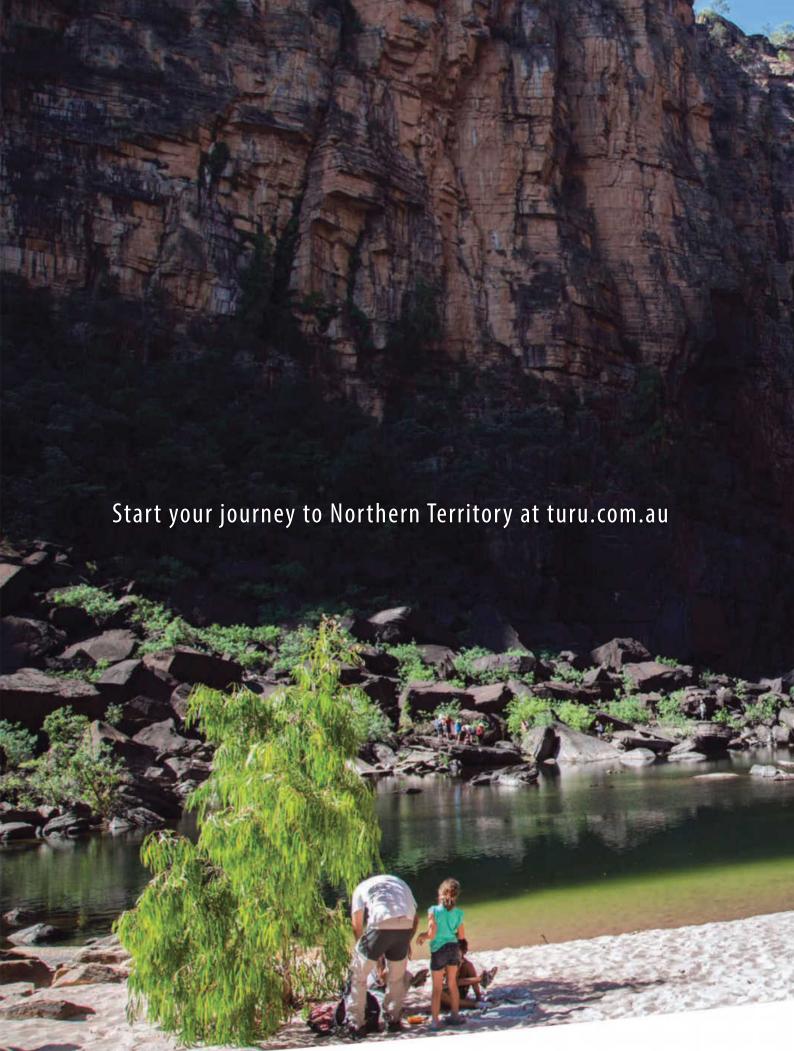


PLUS: DISCOVER which animal is the dirtiest fighter / LEARN how a scarf can make you invisible





# Knowledge



[12] What if Japan had invaded Australia during World War Two? Well, it could have happened... and almost did.



Disasters from the past that claimed thousands of lives, toppled empires and continue to influence the world to this day.



Flimsy, rickety planks form a terrifying route up China's Mount Hua – 2,000 metres above ground. Our advice: don't look down!



There are more things living on every square centimetre of a leaf than there are people living in Sydney and Melbourne combined.



Astrophysicists believe that our Milky Way might be a one way space-time tunnel that could lead us to another part of the universe.



Henrietta Lacks died in 1951, nine months after being diagnosed with cervical cancer. But her cells have saved millions of lives.

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How fast can we run? Why do we get hiccups? The most fascinating questions about our bodies answered



Ross Ulbricht operated the world's biggest online drugs store. He quickly became the most wanted criminal in the USA.



It looks harmless and shares the savanna with some extremely dangerous animals. But the honey badger gives as good as it gets.



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The bird with some fast life lessons to be learned

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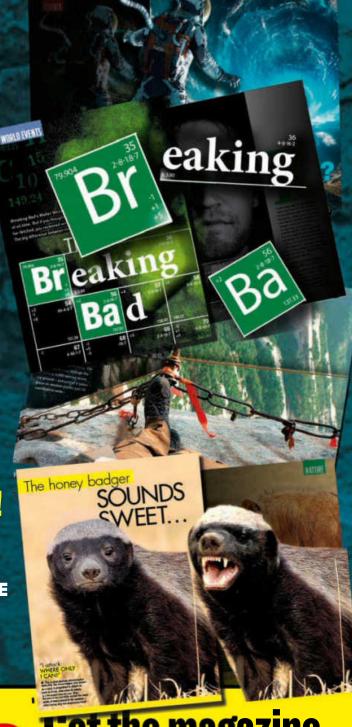
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Why honey badgers have both brains and brawn p80

More great extras throughout the issue!



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# WELCOME

If a week is a long time in politics then 70 years is an unimaginable period in historical terms. There would be few Poms that lived through World War Two who could ever have imagined in their lifetime a British and German leader sitting in the same room, let alone the European Union being formed. And how many people who watched nervously from the sidelines in the 1960s as the Cold War escalated between the USA and the Soviet Union ever imagined that the two superpowers would one day sign nuclear arms reduction treaties?

Similarly, how many Australians who lived in the shadow of a potential Japanese invasion from 1939-1945 could have

> dreamed that the enemy would become a friend over the space of a couple of decades? Not many, judging by the paranoia that coursed through the country's veins at the time, much of it administered by the government of Prime Minister John Curtin, who led Australia through a large chunk of World War Two.

For history lovers – myself included that's one of the fascinating things about the subject: just how unscripted the world really is. And how no one really knows how today's plot lines will play out. Vince Jackson, Editor



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t's going to be anything but plain sailing – that much is already clear to team captain Daryl Wislang as he studies the satellite images on his monitor. Leg 5 is considered the ultimate challenge in the Volvo Ocean Race: his team must battle their way across more than 6,700 nautical miles (12,400 kilometres) en route from New Zealand to Brazil, straight through the roaring waves of the Antarctic Ocean.

In 2015, however, nature has one very specific challenge in store for these extreme sportsmen: racing towards their yacht, at a speed of 190km/h, is Cyclone Pam and it's churning the sea into waves ten metres high. If they want to win the toughest race in the world, they can't afford to make any major changes to their route. That's why Daryl Wislang is staying his course – and sailing straight between the frozen edge of the Antarctic Ocean and the fringes of the Pacific cyclone. Abu Dhabi Ocean Racing's 20-metre-long, single-masted yacht clatters across the ocean. Every five seconds,

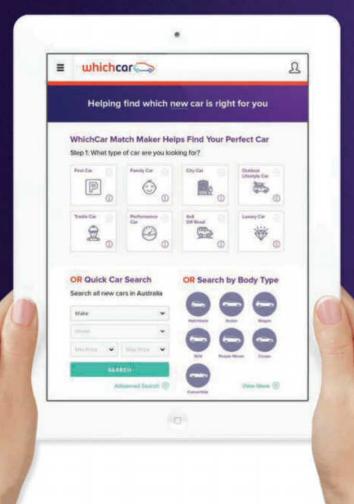
the boat smashes onto the water's surface – for the eightman crew that means 720 bone-shaking impacts per hour. That's the drill from sunrise to sundown. But a single lapse in concentration, miscalculating the size of a wave, one degree too much tilt and the team would lose control of the boat. The sea would tear it to pieces.

Crew members sleep in shifts, tied to their bunks by a rope. Every movement below deck requires tremendous amounts of energy – coordination is difficult when you're living life at a 45-degree angle. It's only once they've passed Cape Horn off South America that the sea finally calms. And that's when the crew realise that the direct route has paid off. After almost 19 days of back-breaking work, Abu Dhabi Ocean Racing are the first boat to reach Leg 5's final destination in Itajai, Brazil, ahead of the MAPFRE team. After 12,549 kilometres battling through the enormous Pacific waves, there's just 32 minutes and 46 seconds between the two teams...

# Get new car advice from the experts – not your barista.

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**9.35AM** Priest serving on a mission on Bathurst Island, 70km away from Darwin, spots unidentified aircraft.

9.37AM Royal Australian Air Force Operations receive communication about suspicious planes. Debate about informing Army/Navy HQ.

**9.58AM** Japanese fighters begin to arrive over Darwin, first strafing the minesweeper HMAS *Gunbar*. Air-raid sirens finally sound.

#### **DIRECT HIT**

The remains of an Australian ship smoulder in the background after Japanese planes attack Darwin in February 1942.

# WHAT IF

Could it really have happened? In a World War Two special, we reveal the secret Japanese military plans that nearly changed Australian history forever

own Pearl Harbour. At 9.37am on 19 February, 1942, the Royal Australian Air Force Operations receive reports that "a large number of aircraft" have been observed passing over Bathurst Island in the Timor Sea, around 70 kilometres from Darwin. The protocol for this situation is simple: to immediately communicate

the sighting to Area Command Headquarters, who then inform the Navy and Army HQs.

But there's a delay. A discussion develops within Air Force Operations about whether the planes are, in fact, returning American P40 fighters, and not enemy aircraft. No alarm siren is raised in Darwin until just before 10am. Valuable minutes are squandered.

What happens next is etched in Australian history. "All hell broke loose," says eyewitness Aircraftman Stanley Hawker of No 2 RAAF Squadron. "The Japanese bombed the ships in the harbour, and scored many direct hits. A bomb hit the post office and killed all in the building. They bombed the hospital and the hospital ship Manunda. They hit the oil tanks and



10.40AM First wave of bombers leave Darwin area, attacking two American vessels on the way back to their aircraft carrier.

11.58AM Second wave of Japanese planes appear, splitting into two separate formations, and bombing RAAF Base Darwin.

12.20PM The first-ever air raid on Australian soil ends; at least 243 Australian and Allies are killed in the attack.





set them ablaze... it was pretty scary."

Forty minutes later, a total of 188 Japanese aircraft – using a combination of strafing and divebombing – have sunk three warships, five merchant vessels and another 10 ships. The area in and around Darwin Harbour is in chaos. But the attack isn't over. At 11.58am, just over an hour after the first assault ended, the

town's air raid sirens are wailing again.
Another wave of enemy planes scream through the heat haze of the Top End skies, this time bombing the RAAF base at Parap for 25 minutes.

By the time the Japanese pilots are heading back to their carriers, 28 military aircraft have been destroyed, along with the aforementioned ships; most of Darwin's civil and military facilities lay in tatters. When human casualties are counted, 243 Australians and Allies are dead, another 400 wounded – a figure that would be higher if the majority of Darwin's women and children hadn't been evacuated a few months previously.

Although the Australian authorities try to censor the newspapers in Sydney and Brisbane in the immediate >

aftermath of the attacks, the *Lowe Report* – a government commissioned inquiry into the events of 19 February 1942 – makes reference to the fact that "by the middle of the afternoon people were seeking to leave the town by every means available."

Servicemen are fleeing their posts, heading south or even going bush. They, like the majority of Australians living through World War Two, are convinced that the raid – the first by a foreign military on Australian soil – is the precursor to a Japanese invasion. From which full occupation, and the end of the Australian way of life, will certainly follow...

#### WHY WERE AUSSIES SO FEARFUL OF THE JAPANESE?

By the time Japanese bombers were swooping into Darwin Harbour, the Japanese Empire had already pounded its fist over much of Asia, becoming the dominant force in the region, evoking comparisons with Nazi Germany's march through Europe. Taiwan had been under Japanese rule since 1895; Korea since 1910. Manchuria was detached from China in 1931. The Imperial Army, under the command of Emperor Showa, proceeded to maraud over a whole swathe of territories (Malaya - now Malaysia - the Philippines and Thailand, to name a few). Singapore had fallen under the Imperial flag only a few days before the Darwin raid.

In the months that followed, 88 people were killed in Broome, Western Australia, when Japanese fighter planes attacked the remote outpost. Sydney Harbour was also penetrated in a raid by three midget-class submarines, a mission that claimed 21 lives.

"Australians not unreasonably thought that having conquered most of south-east Asia, the Japanese would simply keep going," says Australian historian Peter Stanley. "It was logical – and they'd been fearful of Japanese aggression for fifty years, fears evoked by novels, plays

and films. The Curtin government [Prime Minister John Curtin, who led Australia from 1941-1945] understandably warned Australians to prepare for attack or even invasion – as the notorious poster put it 'He's Coming South'."

Curtin's administration, and
Australia's military planners, had
always been suspicious of Japan's
intentions, especially given Australia's
relative military weakness. Even before
Malaya fell into Imperial hands, the PM
had reached out to both British leader
Winston Churchill and American
president Theodore Roosevelt, saying,
"It is beyond our capacity to meet an
attack of the weight the Japanese
could launch [on Australia]."

Just two days before the Darwin attacks, the Prime Minister was compelled to make a statement in the *Sydney Morning Herald*, stating that "the protection of this country is no longer a question of contributing to a world at war, but of any enemy threatening to invade our shore."

But in common with many modern-day historians, Peter Stanley is convinced that the Japanese had no concrete invasion plans. In a paper written for the Australian War Memorial website, he insists that Curtin's government "exaggerated the threat, and that the enduring consequence of its deception was to skew our understanding of the invasion crisis of 1942."

#### DID THE JAPANESE MILITARY PLAN TO INVADE?

In an ironic twist to the World War Two story, while John Curtin was preparing to whip the Australian public into an invasion frenzy – on the back of scant factual evidence – there were elements within the Japanese military who were eager to realise the PM's prophecies.

In December 1941, the head of the Navy General Staff's Planning section, Captain Sadatoshi Tomioka, began pushing a strategy that would involve invading northern Australia, reasoning



#### DARWIN

19 FEBRUARY 1942

A total of 242 Japanese aircraft, in two waves, blitz the strategically important town, leaving 243 dead and more than 400 injured. The raiders are led by Commander Mitsuo Fuchida, who also headed up the first attack on Pearl Harbour.

#### BLUE MUD BAY

NATE IINKNOWN

Unconfirmed sightings of abandoned huts, and a possible bush airfield, suspected of being used by clandestine Japanese units.

#### **NEAR THE WESSEL ISLANDS**

22 JANUARY 1943

An Australian reverend, Leonard N. Kentish, is taken prisoner aboard a Japanese float plane after his ship is bombed. He is later executed.

#### KATHERINE

22 MARCH 1942

Nine bombers fly more than 200km inland – the furthest south of any Japanese raid. Damage to the town is minimal, but one local is killed.

# TARGET AISTRAIL

TUWNSVILLE

25/26/28/29 JULY 1942

Over three nights, a small number Japanese flying boats target the town, but most of the bombs drop either in the sea or harmlessly outside of the main hub.

Between February 1942 and November 1943, Darwin was bombed a total of 64 times. And although the infamous aerial attacks on the Top End town overshadow any other military incursion on Australia, regions all around the country's coast were targeted by the Japanese during World War Two. There were around 100 air raids against Australia during 1942 and 1943.

#### SYDNEY

29 MAY 194

Three midget submarines enter Sydney Harbour after dark [photo left, bottom], one managing to fire a torpedo which explodes under HMAS *Kuttabul*, killing 21 sailors. Two subs were stopped, their crews committing suicide. A third escaped the Harbour, and wasn't discovered until 2006.

"AUSTRALIANS THOUGHT THAT HAVING CONQUERED MOST OF SOUTH-EAST ASIA, THE JAPANESE WOULD SIMPLY KEEP GOING."
PETER STANLEY, HISTORIAN



that the United States was likely to use the country as a base for counter-offensives in the South-West Pacific. He, and other supporters of the plan, argued that Australia's north-eastern and north-western coasts were poorly defended, and that the invasion could be carried out by three divisions – between 45,000 and 60,000 men. Another proposal on the table was to invade Australia's east coast while other Japanese forces took Fiji, Samoa and New Caledonia.

Over the following months, Tomioka and other Navy representatives floated the idea to the Army – but ultimately, despite heated disputes, couldn't reach an agreement. The Japanese Army insisted that at least three times the amount of men would be needed for such a plan, with one senior general labelling it "so much

gibberish". Japanese PM General Tojo also knocked back the suggestion.

And so in late-February 1942, a compromise was reached between the Navy and Army to isolate Australia rather than invade it. In this context, the attacks on Darwin – and therefore the Kokoda Track campaign – can be seen as missions to stop the Allies from using the region as a base from which to mount attacks against the Japanese island chain.

"The generals of the Army General Staff and the Prime Minister of Japan did not see a need to commit massive troop resources to the conquest of Australia, with the massive logistical problems that would produce," says historian Henry P. Frei. "The generals were confident that Australia could be bullied into surrender to Japan by isolating it completely from the United

States and by applying intense psychological pressure."

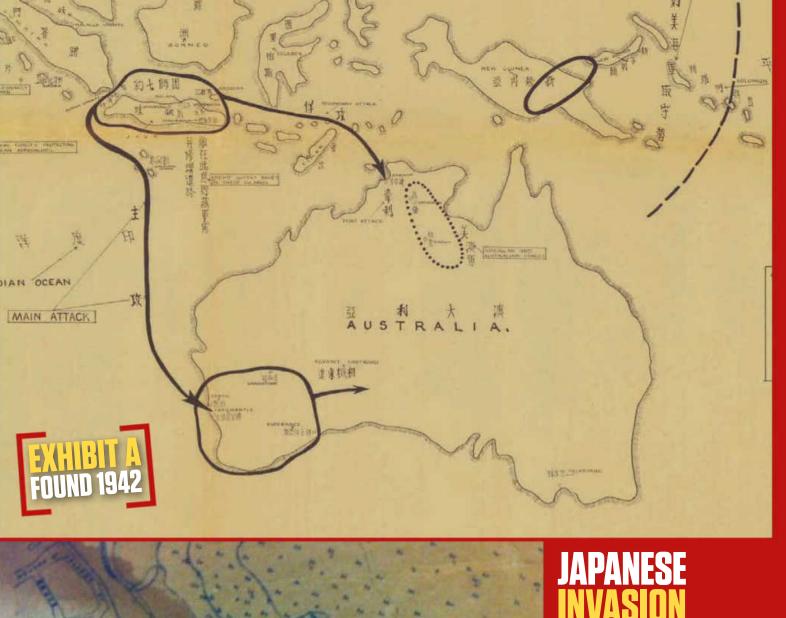
It's believed that Prime Minister
Curtin's administration had no
intelligence of these behind-thescenes wranglings, and only found out
that Japan had decided not to invade
in the middle of 1942 – yet chose not
to publicly admit the threat no longer
existed for another year.

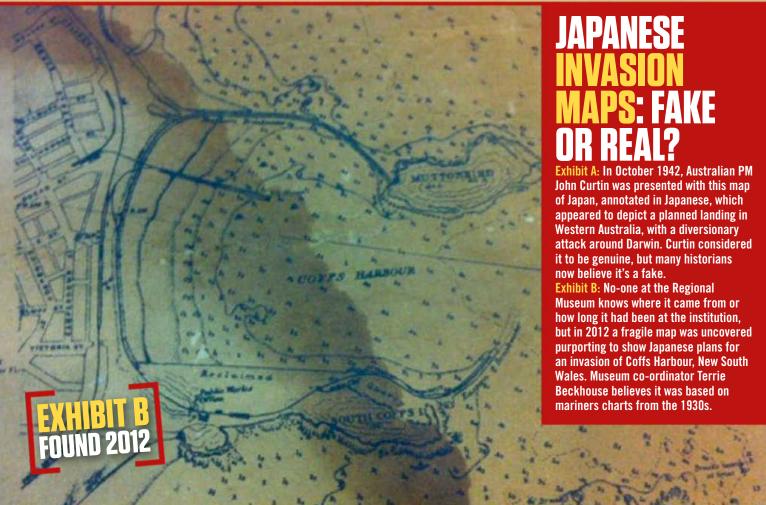
"Various unrelated actions around Australia's perimeter - the bombing of Darwin, the fighting in Papua, the submarine raid on Sydney Harbour - are stitched together to look like one broad operation, the Battle for Australia," Peter Stanley said in an essay for the ABC. "This name is taken from a speech Curtin made following the fall of Singapore in February 1942, in which he anticipated that the fall of the great British base in Asia opened a 'Battle for Australia'. The phrase is not history, it was a *prediction* – one that did not actually come to pass."

#### DID JAPAN HAVE SECRET BASES IN AUSTRALIA?

The morning mist has evaporated. It's a typically hot, sticky January day in York Sound, Western Australia, 1944. Three landing parties are anchored in an inlet just off the red mainland, watching squiggles of white smoke rise from a nearby mountain. Cautiously, they take the decision to go ashore, exploring the local coastal area for two hours, recording some 8mm footage of what they see: ochre rocks, clumps of small trees, a couple of abandoned camp fires. And then, as stealthily as they arrived, the Japanese Army Reconnaissance party departs on their vessel, returning to Timor.

The episode, recounted in forensic detail on Peter Dunn's Oz At War website, is one of two Japanese landings in Australian territory to have been confirmed by official documents. The other, known as the Kentish Affair, saw Reverend Leonard N. Kentish taken prisoner – then executed – by





the Japanese Navy while on a boat in Australian waters near the Wessel Islands, off the northern peninsula of Arnhem Land.

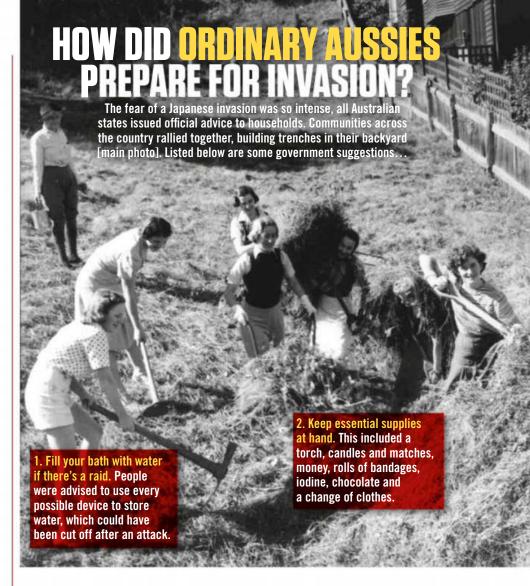
While it's debatable that Japan could have ever mounted a full-scale invasion, these events prove that the Imperial Army did, on at least two occasions, slip through the country's fragile wartime defences. The Oz At War website also lists several unconfirmed Japanese landings in Australia during World War Two, the most intriguing of which involved a suspected make-shift airstrip at Blue Mud Bay, in Arnhem Land.

On 22 March, 1942, Jack McKay, the owner of Mainoru Station, reported seeing, flying over his land, the team of Japanese aircraft that had just bombed Katherine - without the fuel drop tanks usually required for long-range flights. McKay also says that local indigenous people from the Gulf of Carpentaria had spoken of observing "plenty China men and big silver birds". Furthermore, Army pilot Senior Sergeant Charles Miller reported seeing in the same area a village of rudimentary huts close to a level, graded claypan, suggesting the existence of a rough airfield.

There are also unconfirmed reports of more than 100 Japanese Marines coming ashore at Cromarty, Queensland; three Japanese commandos being killed by stockmen 50 kilometres west of Townsville,



# BRUTE FORCE A captured Allied pilot is led away by the Japanese secret police, known as the Kempeitai. Torture was commonplace in the unit.



Queensland; and a Japanese landing party being ambushed by Australian soldiers in the Kimberley region, Western Australia.

#### WHAT WOULD LIFE BE LIKE UNDER JAPANESE RULE?

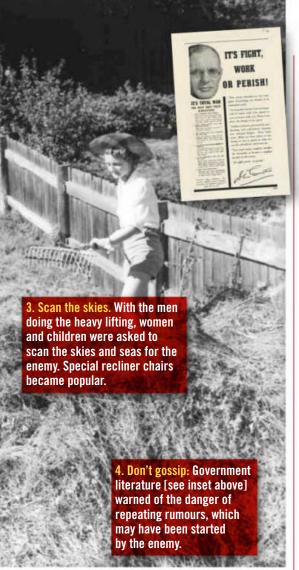
December, 1941. Captain Sadatoshi Tomioka, head of the Navy General Staff's Planning division, is once again spruiking his strategy of invading Australia, in an attempt to weaken the United States' influence in the region. Only this time, his counterparts in the Army are listening. They no longer fear a Soviet invasion in Manchuria, and agree to release 200,000 troops from the Kwantung Army.

After a series of strategic air attacks in northern Australia, including Darwin, the Japanese Navy capitalise on a decision by Allied commanders to focus on the Pacific region, and

assemble Imperial warships in the Coral Sea, comprehensively defeating the Allies. Buoyed by the victory, Japanese special forces attack Port Moresby, Papua New Guinea, where demoralised Australian troops are easily defeated.

And while the Allies are distracted in the Battle of Midway in the Pacific, the first battallions of enemy troops are landing on Australian soil, breaching the Eastern seaboard between Cairns and Townsville.

Of course, this scenario is an alternate history, or 'counterfactual history' – a new branch of academia which seeks to answer 'what if' questions, based on subtle changes in historical events. Japan's possible invasion of Australia is a plausible candidate for debate, given that a) Japan's military leaders seriously considered the strategy, and b) the Empire's aggressive expansion



#### "RUMOURS ARE OFTEN SPREAD BY THE ENEMY. DON'T LISTEN TO THEM; DON'T REPEAT THEM." GOVERNMENT POSTER

into the region during the first half of the 20th century.

So in this context, with Japanese forces having successfully invaded Australia, what would everyday life be like? Using earlier colonisations in the Asian region as a reference point, we can ascertain the following...

**Secret police:** Known as 'Japan's Gestapo', the Kempeitai [see photo far left] are charged with reinforcing the ideology of the military – by any means necessary. The Kempeitai

regularly perform violent interrogations, using an extensive network of torture chambers. Anyone suspected of being anti-Japanese in occupied Australia is rounded up, and even killed – as happened during the occupation of Singapore between 1942 and 1945 when 50,000 ethnic Chinese were massacred. Informants are commonplace. Neighbours, friends and even family can't be trusted.

Comfort women: Don't be fooled by the euphemism; it's a phrase used to describe women who serve in Japanese military brothels. During World War Two, it's estimated that up to 200,000 women from all over the Japanese empire are – against their will – put into the sex industry. With hundreds of thousands of Japanese troops based in Australia during the initial stages of occupation, local women are coerced in similar fashion.

Censorship: For the first decade of Japan's occupation of Korea (1910-1945), there are no Korean-owned newspapers. Between 1920 and 1939, more than 1,000 newspapers are seized without warning. In Australia, as in Singapore, only Japanese propaganda movies are shown at cinemas. Radio stations broadcast pro-Japanese speeches; tuning into foreign broadcasts means risking punishment or death.

Rations: In the immediate years after the war, food is in short supply. As happened in Singapore, a ration card system is introduced, with allocations limited to basic provisions such as bread, rice and potatoes. Australia's fertile agricultural lands are used to both feed the Japanese military and the population back in Japan.

#### COULD AUSTRALIA BE INVADED NOW?

Seventy years after Japan's surrender in World War Two, there's a new threat on the horizon according to some experts: China. Earlier in



#### WHAT WAS 'INVASION MONEY'?

As Imperial forces worked their way through south-east Asia, the Japanese Military Authority authorised the use of 'occupation money' or 'invasion money' to replace local currency. All hard currency was confiscated, and swapped with printed notes that declare 'The Japanese Government' as the issuer. The Japanese issued the Oceania Pound (plus shilling denominations) for use in Australian mandated territories such as New Guinea and the British Solomon Islands, fuelling rumours that Australia was on the verge of being invaded.

2015, the superpower announced it would be jacking up its military budget by 10 per cent to \$180 billion, making it the second-biggest military spender in the world, behind the US. This comes as China is busy making territorial claims in the East and South China Seas, making nervous neighbours of nations such as Japan and South Korea.

James Fanell, former head of intelligence for the US Pacific Fleet, recently warned that China's military build-up, if left unchecked "will necessarily disrupt the peace or stability of our friends, partners and allies."

Before he died in March 2015, former Australian PM Malcolm Fraser ruffled a few diplomatic feathers by suggesting that Australia now risks a disastrous war with China by protecting US interests on this side of the world. He went so far as to name Pine Gap, the secretive Australian-American spy base near Alice Springs, Northern Territory, as a possible target for the Chinese. "Our armed forces are so closely intertwined with theirs [the United States] and we really have lost the capacity to make our own strategic decisions," Fraser says. "It's time for Australia to grow up."

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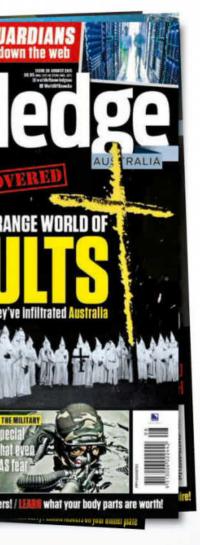




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# Planet of The total surface area of all the world's leaves is around one billion square kilometres. A fascinating microcosmos exists above our heads - one that enables our every breath











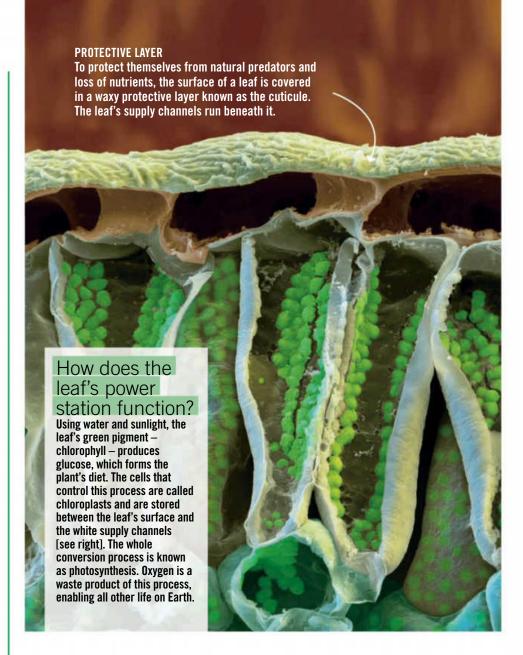
#### HAVE LEAVES DEVELOPED THEIR OWN FIREWALL?

In the northern hemisphere, spring represents an incredible energy miracle. It's when nature unfurls the biggest solar sail on the planet, putting the most effective power station on Earth back in business – trillions upon trillions of leaves, creating life from sunlight. As soon as sunlight hits a leaf, sugar starts to be produced, which stimulates the plant's growth – a process known as photosynthesis. Oxygen, the basis of all life on Earth, is the waste product of this conversion.

A human needs roughly the amount of oxygen produced by 10,000 leaves. So it's comforting to know that a single beech tree pumps 9,000 litres of oxygen into the atmosphere every day during the energy conversion process – enough to provide five human beings with air. Biochemists have tried to imitate this natural miracle artificially – with only limited success.

On the surface of one leaf alone, there are more inhabitants than there are in the whole of Australia. Bacteria, microalgae, yeasts - the biomass of these tiny residents equates to roughly 14kg per hectare. Like some kind of giant commune, every inhabitant has its own specific purpose. Most are there to protect the leaf rather than to destroy it. Some bacteria, like Pseudomonas fluorescens Bk3, are even able to activate an 'alarm' gene if a harmful fungus attacks the leaf - which causes the leaf to blockade its cell walls and install a type of firewall.

Other special forces doing battle on the leaf's surface include two common types of bacteria: *Methylobacterium* and *Sphingomonas*. They protect the leaf from any 'stowaways' that insects have unwittingly carried onto it. A single butterfly can leave behind up to 10,000 microbes



when it pays a leaf a visit. In the phyllosphere, there is a constant battle raging between the leaf itself and its attackers – a war that the leaf wouldn't be able to win without the help of its resident allies.

#### DOES EVERY LEAF HAVE ITS OWN SELF TIMER?

Weeks of drought, torrential downpours with raindrops 100 times the size of the bacteria itself, severe storms, temperature fluctuations: all of these obstacles necessitate elaborate survival strategies. And this is exactly what the leaf-dwellers have developed over the course of evolution. During a storm, some bacteria secure themselves to the surface of the

leaf with tiny sticky threads. Others secrete a soap-like substance when it rains that reduces the water's surface tension so that the raindrops roll right off their backs.

At the same time, the leaf's waxy surface, known as the cuticle, prevents water loss and serves to keep the nutrients that have been absorbed through the tree's roots exactly where they are – within the leaf. So how do the bacteria manage to get nutrients? In reality, no leaf is completely smooth. Glandular hairs form gigantic columns, deep stomata cut through the surface. In these areas there is no protective layer. And it's there that gases, proteins, sugar and oils stream out of the leaf's interior and

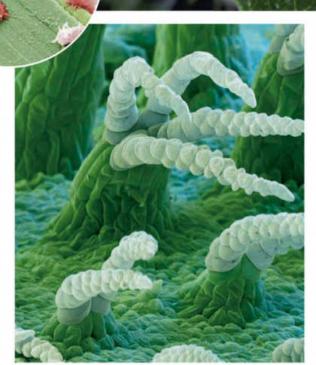
# The secret universe of the phyllosphere

The habitat of the leaf's surface, the phyllosphere, is one of the most diverse biotopes on Earth. Aquatic bacteria [inset] gather on the stomata, where they feed on nutrients on the leaf's surface. Insects like flies [larger image] use the leaves as a nursery for raising their offspring.

become the life source for the bacteria, algae and yeasts. In this way veritable oases of life form on the leaf's surface. At the same time the outflowing oils and scents can serve as a warning signal: if the surface of a leaf is compromised, after being attacked by a fungus for example, it releases chemical messengers – which broadcast a command to other leaves in the vicinity: 'Strengthen your firewall!'

And how do the trees themselves even know when it is the right time to bloom? "Even as buds, leaves have an inner clock that keeps track of how long it is light for each day," explains Dr Seth Davis, a biologist from the Max Planck Institute. Plants and trees are constantly comparing the light conditions in their surroundings with the expectations of their inner clock so they are able to tailor and control their cycles of growth.

To perceive the light around them, leaves possess photoreceptors for red, blue and ultraviolet light. In the process they can even predict dawn and dusk and adjust their metabolic processes accordingly. And that's why our planet of leaves doesn't just offer a unique habitat to billions of organisms. At the same time, this biotope serves a remarkable and vital purpose – as nature's very own alarm clock.



# How do leaves protect themselves from attack?

The underside of a common stinging nettle leaf is covered in long, hollow hairs filled with formic acid. A ten-millionth of a gram of this toxic liquid can cause a painful inflammatory reaction in humans. And the stinging nettle is by no means the exception. Poisonous substances in the cells, chemical substances which delay the growth of enemies, sugar coatings on leaves around the world thousands of types of leaves have developed various defensive strategies to protect

# How much power do a leaf's energy pipelines have?

Thousands of veins criss-cross a leaf like a river delta. They provide the surface of the leaf, called the phylloplane, with water. In the process they can pump water from the roots of the plant to the tree crown, a distance of up to 130 metres. The veins also ensure stability: water lilies have the supportive tissue on their leaf's underside to thank for their buoyancy. In addition, the underside of the leaf is protected from hungry fish mouths by hard, sharp bristles.



# COMPLETE YOUR WORLD OF KNOWLEDGE COLLECTION!



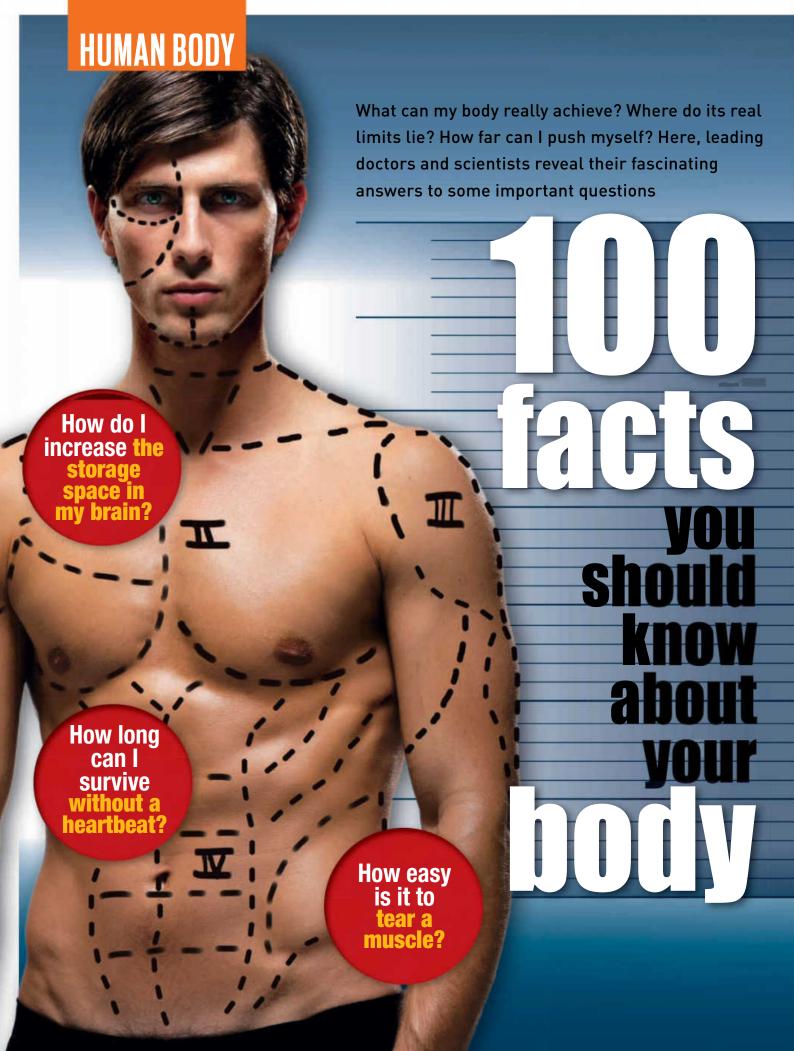


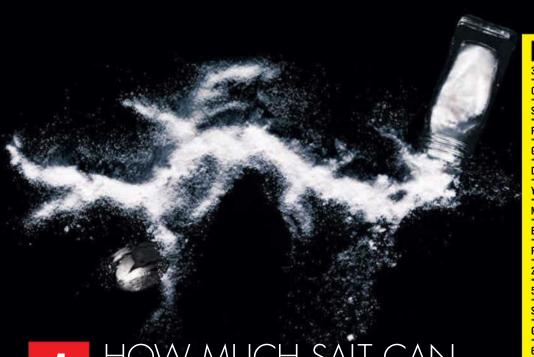


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#### HOW MUCH SAIT CAN MY BODY COPE VVITH?

"Eating too much salt over a period of months dehydrates the body and also raises blood pressure. This increases a person's risk of a heart attack many times over," explains cardiologist Dr Heiner Greten. The long-term effects of ingesting too much salt have also been illustrated in a US study: according to their calculations, if every American citizen gave up just one teaspoon of salt per day, up to 92,000 deaths could be prevented annually in the

US. Closer to home, a recent report claims that reducing our daily salt intake by 30% (from nine grams to six grams) could save more than 7,000 Australian lives a year. The Heart Foundation recommends adults consume no more than six grams of salt per day. The problem: many foods contain such high levels of salt that after a normal-sized breakfast and lunch, this limit has often already been exceeded [see table].

PRODUCT /////////	///////////////////////////////////////	///////////////////////////////////////
3 rashers of back bacon	3.6 등	60
Caviar	1.4	23 8 90 27 13 2 46 21 30 24 46 21 30 24 24 24 24 24 24 24 24 24 24 24 24 24
Small packet of crisps	0.5	8 le /
Pasta ready meal	Salt ii	90 <u>g</u>
Gherkin	1.6	27
Dairylea cheese spread	0.8	13
Yoghurt	0.1	2 2
Macaroni cheese	2.8	46 €
Bagel	1.2	21 😤
Potato salad	1.8	30
2 slices gammon	1.4	24 W
50g smoked salmon	2.2	37
Small tin of baked beans	0.6	10
Grilled kipper fillet	8.1	135
6 chicken nuggets	2.4	40
40g salted nuts	1.5	25
Parma ham	1.7	28
Pizza	4.8	80
Red cabbage	1.5	25
50g pretzel sticks	2.2	37
Breaded fish	2.5	42
1tsp English mustard	0.5	8
Tomato ketchup	0.7	12
Sausage	1.1	19

# Ouch!

# HOW CAN A BROKEN BONE HEAL MORE QUICKLY?

The amount of time it takes

for a broken bone to heal (six to 12 weeks) depends largely on how far apart the fractured bone parts are from one another. The process is slowest when a gap between the two broken bones remains after setting. But if a bone has been stabilised with the help of screws and plates, and the gap has therefore been closed, the healing period takes only half the time.

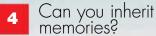
The best way to speed up the process?

Take 1,000 milligrams of calcium daily (that's 30g of nuts or 200g of yoghurt.)



# Can you hack into another person's heart?

The wireless connection that doctors use to facilitate the insertion of a pacemaker provides hackers with a door into the body. In 2012, hacker Barnaby Jack succeeded in using a damage code to subject a test device to an 830-volt electric shock. A human would have been killed immediately – the perfect assassination.



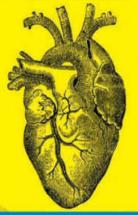
Neurologist Rachel Yehuda discovered abnormal stress reactions in babies whose mothers fell pregnant soon after the attacks on the World Trade Center in 2001. As a direct result of their experiences during 9/11, the regulation of several genes in their bodies was noticeably affected. The manipulated genomes were then handed down to their offspring. "It became apparent that memories leave behind traces in our DNA." explains Yehuda.



#### WHICH TYPE OF PAIN IS THE MOST INTENSE?









**PAIN LEVEL: 2** 

**PAIN LEVEL: 4** 

**PAIN LEVEL: 8** 

#### **PAIN LEVEL: 9**

#### PAIN LEVEL: 10

"Like scalding yourself with hot water": because only the pain sensors in the uppermost layers of skin are activated, the pain signal sent to the brain is much weaker. The brain therefore

knows that the injury is

not life-threatening.

"An immense pressure - albeit one that quickly recedes": a broken nose is one of the most common injuries to the face. Unlike organ injuries or other broken bones, the pain usually subsides quickly.

"Like a jackhammer crashing into the skull": migraines are caused by the inflammation of blood vessels in the cerebral membrane. As they swell up, they irritate the surrounding tissues and activate the pain sensors.

"Like a hot needle being rammed into your chest": cramps in the heart muscle, known as angina, count as one of the most severe levels of pain. They usually last between a few seconds and several minutes.

"Worse than a gunshot wound": acute renal colic occurs when kidney stones or blood clots block the ureter. The kidneys are acutely sensitive to pain - a life-saving mechanism, because renal colic can be fatal.

#### What's the toughest substance in the body?

It's a shiny off-white colour, protects each of our 32 teeth and is composed of 95% hydroxyapatite, a crystalline material. Similar in strength to granite, tooth enamel is the toughest substance in our body.



#### Can you die of embarrassment?

Yes, even if this is extremely rare. The first documented case was in 1860, when a woman who had been caught stealing in front of a large group of people died on the spot. It turned out she'd suffered a heart attack as a result of an extreme rush of adrenaline and other stress hormones. It's not only embarrassing ourselves that can have direct effects on the body: so can feeling embarrassed on behalf of

someone else. Researchers from the University of Marburg discovered that people automatically feel empathy when they observe other people being humiliated - this can then unleash real psychological pain in the onlooker. The closer you are standing to a person, the more intensely embarrassed you will feel on their behalf, because you are able to sympathise more.

#### WHAT **HAPPENS** WHEN YOU STOP **SMOKING?**

Around 13% of Australians are addicted to nicotine, raising their risk of contracting numerous illnesses - including lung cancer and heart disease. But as soon as a person gives up smoking, their body begins to repair the damage. The detox starts after just a few minutes and takes some 15 years to complete.

#### After 20 minutes

the heartbeat and blood pressure begin to return to normal. They are raised while a person is smoking a cigarette.

After 5 days the body has broken

down most of the nicotine.

#### After 1 to 9 weeks

the cilia on the mucous membranes of the lungs have been cleaned. This strengthens the immune system.

4,000 CHEMICALS are found in tobacco smoke. At least 50 of these are carcinogenic substances.

#### After 12 hours

the increased level of carbon monoxide in the blood returns to normal. The gas is toxic - in large quantities, it can damage the heart and central nervous system.

After 2 weeks

the blood flow and circulation of air in the lungs improves.

After 1 year the risk of heart

disease is halved.

After 15 years ex-smokers have the

same risk of a heart attack as non-smokers.

#### QUESTIONS **ABOUT OUR SKIN**

## ARE THERE PEOPLE WHO HAVE NO FINGERPRINTS?

Yes. Adermatoglyphia is the name for the genetic disorder - people with the condition lack so-called friction ridges on their hands.

#### **CAN SKIN** HEAR?

It's easier to perceive expelled air on our skin and this means we can differentiate between consonants as a result.

#### CAN MY SKIN BETRAY ME?

A drug test can reveal whether someone has taken cannabis. The drug can be found in the skin up to 12 hours after ingestion.

#### DOES OUR SKIN ATTRACT **MOSQUITOS?**

Three million bacteria inhabit every cm<sup>2</sup> of skin. It's their smells that attract mosquitoes - rather than our sweet blood.

## WHY DON'T WE BURN IN A SAUNA?

Dry air is a much poorer conductor of heat than water. In addition we cool ourselves down by sweating.

#### HOW MUCH SKIN DO WE LOSE?

Our body loses 1.5 grams of skin per day. Mites munch on the flakes.

#### HOW BIG IS OUR SKIN?

If you rolled out the skin of one person, it would cover an area of 1.8 square metres.

**Border patrol**Cellulose filaments form the cell wall. They protect the cell but allow water and gases to pass through it.

The DNA in the cell nucleus consists of up to 247 million storage units, which store all the necessary information encrypted - as 30MB files. Combined, the body's 100 million cells store a volume of data that is equivalent to 7,000 times the amount of all the books ever written.

**30MB** 

**HARD DRIVE** 

**Protein factory**Ribosomes gather together different proteins, such as digestive enzymes that are essential for survival.

Power station
In the mitochondria the cell transforms sugar into energy molecules.

# Does every cell have a brain?

Virtually every cell in the human body functions like a highly complex nano-organism. It consumes food, produces new proteins itself and travels via neural pathways - the body's internet - enabling it to be in constant contact with its fellow cells. What's more: every cell has its own brain, in which its genetic information is stored, and where decisions are made. The cells use this to actively control our body functions and to communicate with one another - very much like the neurons in our own brain. There are also 'brainless' cells too, though, which have no nucleus. These include red blood cells.

#### WHERE DOES THE FAT GO WHEN WE LOSE WEIGHT?

Scientists have discovered that when we shed the kilos, we lose most of our body mass through breathing. Our body metabolises fat, or more precisely the fatty acid, by converting it into carbon dioxide. The gas is then excreted in the breath. A lesser amount is transformed into water and exits the body via sweat, urine or tears. But don't cancel that gym membership yet: you can't lose weight just by breathing faster - you'll only increase your metabolism (and CO2 production) through exercise.

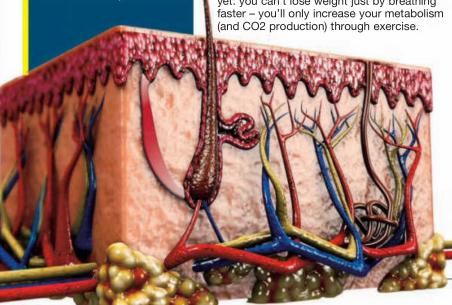


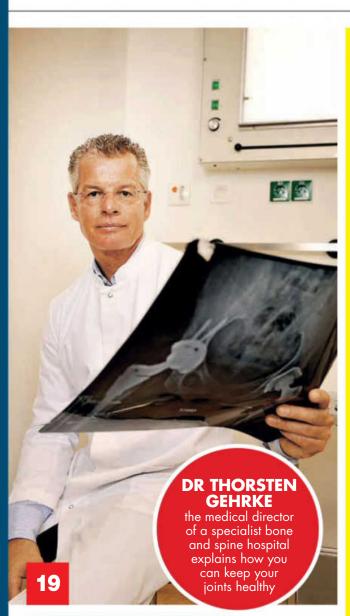
# How many calories does thinking use?

Our brain uses 20% of our total energy requirement - that's about 500 calories per day. Intense brooding uses up just five extra calories per hour, compared to when you're just sitting around not thinking about much at all. Most of the brain's energy is set aside for physical processes, like controlling the muscles. This is also the reason why we use far fewer calories when sleeping, when these bodily processes take place on a much smaller scale, than when

we are awake.







# WHY DO JOINTS STARVE WHEN THEY'RE NOT MOVED?

When we speak of joint pain, the body's cartilage plays a key role. Pain normally occurs when the wear of the cartilage tissue is no longer repaired by the regenerative capacity of the body. The result: the joint starves. The joint's power of self-healing is based on its ability to regenerate the building blocks of the cartilage as well as to form substitute cartilage. Making sure you're providing your body with an optimal supply of nutrients is crucial for regeneration and self-healing. But here there's a difference: unlike most tissues in the body, cartilage contains no blood vessels. Supplying the cartilage with nutrients via the blood is impossible. Instead, nutrients are supplied via the synovial fluid, which washes around the cartilage in the joint cavities. Imagine it like so: when the joint is released, it becomes saturated with fluid like a sponge and takes on nutrients. When strained, the fluid - along with the metabolic waste products - is squeezed out of the 'sponge' again. For this reason regular movement is tremendously important for the regeneration of the cartilage: it's only as a result of joint movements that a constant in and outflow of the synovial fluid is ensured and an optimal supply of nutrients to the joints is guaranteed.

#### QUESTIONS ABOUT OUR HAIR

#### WHO HAS THE MOST HAIRS?

Blondes have roughly 150,000 hairs, brunettes around 100,000 and redheads just 90,0000 hairs on their heads.

#### DOES YOUR HAIR HAVE A SENSE OF TASTE?

The tiny hairs found on the mucous membranes in our nostrils and lungs are just a few micrometres long and can perceive bitter-tasting substances. When these small hairs in the lungs 'taste' nicotine, the organs begin to work harder to clean themselves.

#### HOW RESILIENT IS HAIR?

If you want to tear apart a hair, you'd have to stretch it out and apply a force of 60 kilos. A whole head of hair can withstand a force of two tons.

#### DOES MY HAIR REVEAL WHERE I LIVE?

Chemistry experts in the US discovered that places leave behind a type of chemical fingerprint in our hair. They have already catalogued the individual hair characteristics of 33 cities.

## DO HAIRS CONTINUE TO GROW WHEN WE DIE?

Nostril hairs live longer than our bodies. They continue to pulsate for up to 21 hours after death.

#### DOES MY HAIR KNOW WHEN I'M SLEEPING?

Researchers have observed the activity of the body's biological clock in hair samples. This controls our sleep and wake cycles.

#### HOW LONG DOES A HAIR LIVE FOR?

On average, hairs live for between two and six years. Once the growth phase is over, the hair falls out (after a short rest period) and is replaced by a new one.



# How dangerous is nasal spray?

The active substance xylometazoline in nasal spray helps to combat inflammation in the nasal mucous membranes when a person has a cold. It also makes breathing easier. But for many people, the substance has become something of a drug. Using it for just ten to 14 days can make the membranes dependent on a regular hit of xylometazoline. This is because when the effect of the nasal spray wears off, the mucous membranes swell up again with a vengeance. In order to breathe cleanly, more of the spray must be used - and a vicious circle develops. Some of those affected can get through an entire bottle a day. It might sound like a paradox, but the end result is that the regular use of a nasal spray can lead to a chronic cold. The mucous membranes also become dehydrated, limiting their ability to defend against dust, dirt and germs. In conclusion: nasal sprays with antiinflammatory benefits should only be used for a maximum of seven consecutive days, up to three times a day. If a spray also contains dexpanthenol, this will also have a beneficial effect on the mucous membranes.



## HOW MANY STEPS SHOULD I WALK TO STRENGTHEN MY IMMUNE SYSTEM?

Health experts have long been saying that the best way to prevent, alleviate and even to cure illnesses is to exercise. Just a few steps a day could be enough to outrun disease, so to speak. It's all to down to our metabolisms, which, thanks to a combination of unhealthy diets high in fat and carbohydrates, and a lack of movement, are in a bit of a mess. Hormones form in the fatty tissues which can lead to common diseases like atherosclerosis, diabetes and high blood pressure - even to dementia or depression. But metabolism can be controlled with a healthy, balanced diet. The benefits of regular exercise are even greater than those conferred by healthy eating. The best thing about walking is that

it is so easy. Walking 10,000 steps a day from the age of 25 can help prevent many common illnesses. But it's never too late to start: a marked increase in movement over a three-day period will activate your metabolism. In old age the effects are even greater: the older a person is, the quicker new muscle cells are formed. These break down sugar, decreasing the risk of diabetes and atherosclerosis. The University of Rochester, US, has created a chart that converts other activities into steps. One hour's slow cycling is equivalent to 7,500 steps, brisk peddling equals 14,500 steps, 12,500 steps are covered by jogging for 60 minutes, while swimming can be credited with 11,000 steps.



### How much caffeine is deadly?

A cup of filter coffee contains around 115 milligrams of caffeine. But it's only at doses of five to ten grams of caffeine that a person risks life-threatening caffeine poisoning. To achieve that level, you'd have to drink at least 42 cups of coffee in a single sitting. Energy drinks pose a much more significant risk. Certain brands can

contain up to 240 milligrams of caffeine. Drinking just a few cans of these could lead to potentially fatal heart arrhythmias. US authorities have logged at least five fatalities in connection with energy drinks. All died as a result of a heart attack. The Federal Institute for Risk Evaluation also evaluated the cases and confirmed: "The lower your body weight, the less caffeine you can tolerate.

#### 68 YEARS

is the length of time the longest bout of hiccups lasted. US citizen Charles Osborne hiccupped between 20 and 40 times a minute from 1922 until 1990.

### Why do we get hiccups?

So we don't drown in the womb. Some researchers think that hiccups begin as a foetal digestive reflex that guards against breathing in amniotic fluid in the womb. Or it could be an early way to train respiratory muscles for breathing after birth. During breastfeeding, this reflex also causes a baby's glottis to

close to prevent milk from entering the lungs. After infancy hiccups become unnecessary and decrease in frequency. Frightening someone can help cure the affliction. Why? Because the unconscious nervous system is stimulated, and the body shuts down all unnecessary functions.

### 31

### WHICH FATS STRENGTHEN MY HEART?

The most important thing for heart health is staving off the ageing process. This can be slowed through the regeneration of blood vessels - if we provide the body with the right nutrients. Fat has particular significance: the animal fats in meat or milk products massively accelerate the natural ageing process of the blood vessels. Why? With them, we take in large quantities of (bad) LDL cholesterol. This can narrow blood vessels, triggering a heart attack or a stroke as a result. Vegetable fats offer a healthier alternative. These contain almost no cholesterol and ensure that any high cholesterol values are broken down. As a result vegetable fats act as a kind of fountain of youth for the circulatory system.



### DOs

### VEGETABLE OILS & FISH

PLAICE SALMON HERRING

OLIVE OIL WALNUT OIL RAPESEED OIL

### DON'TS ANIMAL FATS

MEAT COD
BUTTER TROUT
EGG YOLK SMOKED EEL
SAUSAGES MILK PRODUCTS

### THE 10 GREATEST EMERGENCY MYTHS

### SHOULD A PERSON WHO'S BEEN POISONED VOMIT IMMEDIATELY?

A widespread mistaken belief that can have life-threatening consequences. Throwing up should only be attempted if the person remains conscious and if they have

been poisoned with tablets. If the cause is caustic liquids like cleaning fluids, vomiting can damage the respiratory tract, oesophagus or stomach.

What to do: contact the emergency services, and do not allow the affected person to drink anything under any circumstances! Look for the

remains of the poison or the packaging so that the correct treatment can begin immediately.

DR NORBERT ROSENTHAL has practised as a GP for more than 20 years and has worked in A&E

departments. Here he explains the biggest myths about emergency medicine.

### 32 SHOULD UNCONSCIOUS PEOPLE BE GIVEN ARTIFICIAL RESPIRATION IMMEDIATELY?

Ventilation is not the most important thing: the remaining oxygen in the lungs is enough to supply the body for some time. It's much more important to begin heart compressions as soon as a person's breathing and heartbeat stop. That's because when the blood doesn't circulate, it thickens. Oxygen can no longer be distributed around the body - the risk of a heart attack increases. This is the correct order: ring triple zero! Lay the person on their back. Clasp your hands together and press down onto the middle of their chest, roughly 100 times per minute. Continue until the ambulance arrives - around 15 minutes. Without the compressions, a person's chance of survival decreases by 10% per minute.

### IS THE RECOVERY POSITION THE MOST IMPORTANT THING?

Many first responders think so, but it's not always the case. Often people are placed on their side, when they should be on their backs being given CPR. In reality only an unconscious person who is still breathing, and who has no other life-threatening conditions, should be placed on their side in the recovery position. This will prevent them suffocating on their own blood, saliva or vomit. In the recovery position it's important to tilt the head slightly upwards so that the airways remain unobstructed. In the case of upper body injuries make sure that the person is lying on their injured side so that the healthy lung has enough room. If you think a person may have a spinal injury, do not attempt to move them.

### 34 SHOULD FRACTURES ALWAYS BE PUT IN SPLINTS?

This usually brings few benefits. It's much more important to immobilise fractures so that splinters of bone cannot cause further damage or lead to more injuries. The correct method: stabilise the injured limb with tightly rolled pieces of clothing, blankets or cushions. Using a towel, the arm can be fixed to the torso, for example.

### 36 SHOULD I REMOVE THE HELMET OF STRICKEN MOTORCYCLISTS?

If the accident victim is responsive, and is breathing without problems, the helmet must not be removed. But if he or she has lost consciousness, or if their breathing stops suddenly, time is of the essence - and you will have to carefully remove the helmet. This is the correct procedure to follow: in an ideal scenario, there should be two of you. The first helper kneels above the head and clasps the helmet and the lower jaw with their hands. The second helper opens the visor, and unfastens the chin strap. They then take over the stabilisation of the spine and the skull. Next, the first helper carefully removes the helmet, taking care not to jerk the head from one side to the other. Resuscitation techniques should now be started.

### SHOULD MINOR BURNS BE COOLED WITH ICE?

Under no circumstances! For one thing, the temperature shock can further damage the injured tissue. There's also a danger that the victim can develop serious circulatory problems as a result of too intensive cooling.

Burns should actually be treated with lukewarm water, which should help prevent the heat from the burn damaging deeper layers of the skin. Cool it down until the pain subsides – this will take around 15-30 minutes.



### DOES RAISING A PATIENT'S LEGS HELP?

Only in cases of fainting. In other situations, it can even do damage: in a hypothermic patient, for example, the 'icy' blood from the legs could trigger a cardiac arrest. Or, during heart failure, the reflowing blood could overwhelm the organs. First check whether the patient is breathing – if not begin resuscitation immediately! You can determine if there's a circulatory weakness from a weak but regular pulse and shallow breathing.

### DOES URINE NEUTRALISE THE BURNING OF A JELLYFISH STING?

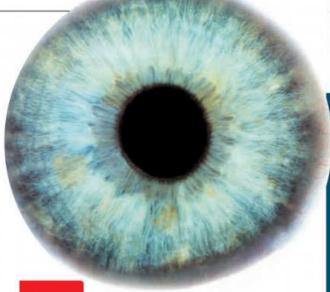
This is a bit of an old wives' tale. The pH value of our urine fluctuates according to the time of day, what we've eaten and whether we're ill or not. Sometimes it's alkaline, sometimes acidic. Therefore urine can actually intensify the effect of the poison sting. Even treating the sting with water can cause the toxic cells to burst and spread their poison. You're better off covering the affected area with vinegar or lemon juice. Proceed with caution and avoid direct contact with the skin; the more you scratch or graze, the more poison will be released into the tissues.

### SHOULD YOU MOVE INJURED PEOPLE FROM AN ACCIDENT SCENE OR NOT?

The basic rule is never to move an injured person unless they are in immediate danger. Only if their life is at risk should you intervene. But be sure not to put yourself in danger! Victims with non-spinal injuries can be dragged away by their feet. Others should have their hands folded together in front of them, while you crouch behind them and grasp their shoulders. Check behind you for any obstacles, then, cradling their head against your upper arms, move away backwards, dragging them with you.

### SHOULD YOU SUCK OUT THE TOXIN FROM POISONOUS ANIMAL BITES?

Toxins generally spread around the body too quickly to be sucked out, so this is a total waste of time - and can even be dangerous to the first aider as they could ingest the poison themselves. This is how you should proceed: calm the victim down, they should limit their movements as much as possible. If they panic, their heart rate increases which means the 'poisoned' blood circulates around the body more quickly. Clean the wound and cool it: this reduces circulation in the tissues. So that the right antidote can be provided in the hospital, it's important to give the paramedics as accurate a description of the animal as possible.



42 Can my eyes get sunburnt?

In principle all types of sunlight can damage the eyes, both the visible wavelengths as well as UV-A, UV-B and x-rays. "We act correctly when we instinctively squint into bright light," says ophthalmologist Dr Susanne Schumacher. Under conditions of high light intensity lasting for more than 30 minutes - such as lying on the beach - the eyes can burn. Photokeratitis can occur, which is when intense sun kills off the outer layers of the cornea (the clear part of the eye at the front of the eyeball). "This manifests itself through burning and redness and should be self-medicated in the shortterm," says Schumacher. Ophthalmologists treat the 'sunburn' with Vitamin A, specialist lotions, therapeutic contact lenses and/or a few hours of rest in a darkened room. The best protection? Make sure your sunglasses have a CE mark and a UV-400 label.

### Can my thoughts make my muscles grow?

If a body part is not moved for a long period of time, for example after an operation, the muscles atrophy. But researchers from Ohio State University have recently completed a trial during which muscles were trained only with the power of thought – without moving the affected body

part. Over a period of six weeks the participants were simply asked to imagine that they were carrying a heavy object such as a dumbbell. The effect: an average increase in muscle strength of 10.8% – and with just 15 minutes of mental training five days per week.

### HOW DO YOU STOP A NOSEBLEED?

The old myth of tilting your head back has been medically disproved: this causes blood to run to the back of the throat and directly into the oesophagus to the stomach, leading to nausea and vomiting. It's better to sit upright and place your head slightly forwards. Pinch the bridge of your nose with your fingers for about two minutes. At the same time place a cold towel on the neck – it will cause a reflexive narrowing of the vessels in the mucous membranes of the nose. If the nosebleed continues for longer than two minutes, seek the advice of a doctor. Do the same if you get them on a regular basis.









### WHAT DOES A FINGERNAIL REVEAL ABOUT MY LIFE?

Fingernails are produced by living skin cells in the finger and are made from keratin, which is also found in our skin and hair. Any change in their appearance can provide clues to an illness [see below]. They provide a

kind of 'timeline' of our health. "Changes in the nails can provide various clues to illnesses affecting a number of different organs, infections or drug intolerances," explains nail expert Dr Dorothee Dill.

#### **LONGITUDINAL GROOVES**

Ridges that run parallel from the nail bed to the edge of the nail. The nail surface is uneven and can appear dull.

External cause: none

Body signals: natural sign of ageing; Vitamin B deficiency (if the grooves are brittle); gout

#### **CLUBBED NAILS**

The nail is rounded and curved noticeably outwards.

External cause: none

Body signals: inflammation of the nail bed; heart or lung disease;

liver cirrhosis; thyroid disorder; iron deficiency

#### SPOON NAILS

The nail plate is relatively even, but the end of the nail is curved upwards. *External cause:* softening of the keratin tissue as a result of frequent handling of abrasive cleaning products

Body signals: circulatory disorder as a result of a lack of iron/anaemia; metabolic disorder; malnutrition; infections; chronic trauma

#### **BRITTLE NAILS**

The nail substance splits off from the edges and is easily broken. *External cause:* scarcity of adipose tissue (perhaps through over-frequent hand washing; use of abrasive cleaning products or nail polish remover high in acetone)

Body signals: unspecific consequence of various skin diseases; hormone disorders; malnutrition

#### **DIAGONAL GROOVES**

Individual or several diagonal furrows on the nail plate.

External cause: injuries to the nail root; interrupted nail growth

Body signals: acute deficiency; infections; toxic or medicinal side-effects

#### **SMALL GROOVES**

Pinhead-sized grooves inside the nail dotting an otherwise healthy nail surface.

External cause: none

Body signals: psoriasis; keratin deformity

#### **SPLIT NAILS**

A single elongated split from the nail bed to the edge of the nail. External cause: mechanical or chemical damage to the nail root Body signals: none

#### WHITE FLECKS

Individual elongated white marks on the nail.

External cause: injury to the nail root, often as a result of a

defective manicure

Body signals: often falsely diagnosed as a lack of calcium but the flecks only have external causes

## 4 billion

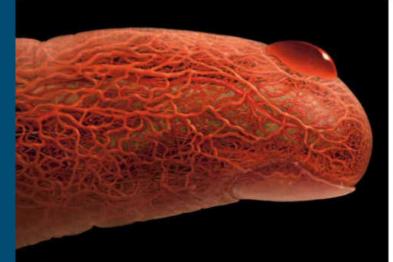
### 46 WHAT RESTING HEART RATE **IS HEALTHIEST?**

Scientists have discovered that the heart beats between three and four billion times over the course of an average life. They also know that once these beats are used up, the heart will go silent forever. In a nutshell, this means that a person's resting pulse has a noticeable influence on their life expectancy. "It's also an important clue as to the heart's efficiency," explains Dr Thomas Lee from Harvard Medical School. A healthy heart normally beats between 60 and 80 times a minute. As a result, a resting pulse of 60bpm is a virtual guarantee of long-lasting heart health. It protects the blood vessels and minimises the risk of cardiovascular disease. On the other hand, a Danish study found that if the resting pulse lies between 81 and 90, a person's risk of death is doubled. Above 90, the risk triples.

### What is perma-jetlag

Working shifts, like in a hospital for example, plays havoc with a person's circadian rhythms. This can result in what's known as perma-jetlag, which has developed into a worldwide epidemic. Sufferers find themselves living in a different time zone to their bodies. The consequence: increased risk of

diabetes and heart problems. The first effects can already be felt by those affected within 24 hours: the brain activity in the thalamus and the prefrontal cortex decreases. These regions control attention and working memory. The resulting lack of concentration can last for up to a month.



Everyone knows the saying "to make the blood curdle". Now scientists at the University of Bonn in Germany have discovered that the phrase can be taken discovered that the phrase can be taken quite literally. They compared the blood of patients who suffered from anxiety with the blood of a healthy group. The result: the blood of the anxiety group showed increased election. increased clotting. It turns out that intense fear and panic attacks really can make our blood clot and increase the risk of thrombosis or heart attack. That's why anxiety sufferers have four times greater risk of dying from heart disease.

### HOW CAN I MAKE MY BODY **INVINCIBLE?**

#### **HOW DO I ACTIVATE MY BRAIN'S STRESS** FIREWALL?

Elite forces use something known as the Mind Eye's technique. Cadets are asked to summon forth positive mental images from their pasts - like a family party or passing an exam - in order to counteract stressful situations. These help to suppress panic.

### WHAT ARE MY LUNGS REALLY CAPABLE OF?

Our lungs possess untapped reserves that most people will never use. Researchers from Ball State University in the US have discovered that stretching your lung capacity over a 15-week period vastly improves your breathing capabilities. Ashtanga yoga is one particularly effective method of doing this.

#### **CAN I EXERCISE** MY BONES?

One of the most effective methods is Whole Body Vibration (WBV) training. The athlete stands on a platform that vibrates at a frequency between 15 and 60Hz. The vibrations are so intense that they actually stimulate the growth of bonebuilding cells.

#### **HOW DO I TURN MY HEART INTO A HIGH** PERFORMANCE ENGINE?

The volume of the heart can be increased by a potential 50%. Even a 40-minute jog every other day is enough to increase your cardiac output.

### HOW CAN I MAKE MY REACTIONS FASTER? 53

Football training hones perception: experienced players perceive more on the pitch and are able to process information more precisely.

### HOW DO I INCREASE MY **PAIN RESISTANCE?**

Navy SEALs use the 4-4-4 technique. For four minutes they alternate between breathing in for four seconds, then breathing out for four seconds. Doing so helps them concentrate on their aim, conquer their fears and weakens their perception of pain.

#### 55 HOW CAN I **GET RID OF** AN 'EARWORM'?

"If a song is running through your mind, it's mimicking an active thought. It's occupying the brain," says psychologist Ira Hyman. If you want to get rid of an earworm. a pleasantly demanding activity can help - like an easy Sudoku or a crossword puzzle. It shouldn't be too difficult though, or you'll get distracted easily - and then the music in your

### HOW HOT IS TOO HOT?

head will start up again.

Chillies can taste unbearably hot - depending on how much capsaicin they contain. This alkaloid stimulates the pain receptors in our mucous membranes and triggers our sensitivity to spice. US pharmacologist Wilbur Scoville measured the capsaicin content in chilli-containing foods by seeing how much water they needed to be dissolved in until no more spice could be tasted. For just one millilitre of pure capsaicin, 15-16 million millilitres of water were required before the spice could no longer be tasted. That makes the Scoville value 16 million.

### SCOVILLE SCALE

0-10 Bell pepper ca. 16 Lower detection threshold for spiciness 100-500 Pepperoni snack 2,500-5,000 Tabasco sauce 30,000-50,000 Pure cayenne pepper

100,000-350,000 Habanero 577,000 Red Savina pepper 855,000 Indian PC-1 pepper (variety of chilli pepper) 23.000 Dorset Naga (variety of chilli) 2,000,000 Ordinary pepper spray ,300,000 Police pepper spray

15,000,000-16,000,000 Blair's 16 Million Reserve, pure capsaicin

### 10 SUBSTANCES THAT PROGRAM MY BRAIN TO 'HUNGRY'

### WHY DOES DIET COLA MAKE ME FATTER THAN NORMAL COLA?

Aspartame is contained in diet soft drinks and is 200 times sweeter than sugar with the same amount of calories.

The artificial sweetener is, for

The artificial sweetener is, for that reason, used in far smaller quantities than natural sugar but has hardly any calories. It does stimulate the appetite though. But unlike natural sugar, it offers the body nothing to curb the appetite. "The brain thinks that the body is lacking nutrients because it has no sugar – and commands us to eat more," explains Peters. This

is how the calories we save from drinking diet cola find their way into the body in another form.

### DR ACHIM PETERS

The diabetologist and brain researcher analysed more than 10,000 studies and found that sweeteners can even cause diabetes.

### CAN CRISPS PARALYSE MY REWARD CENTRE?

Glutamate is found in almost everything salty and long-life such as sauces, snacks and crisps. It's considered the all-purpose weapon among the flavour enhancers as it has a salty-sweet taste and so changes the taste of food, rather than strengthening the flavour. Studies have shown that glutamate affects the brain's reward centre by decreasing the concentration of the 'slimming hormone' leptin. Then the brain sends the command: Eat something! The consequence: No matter how many crisps we've already eaten, we'd still be looking for our next calorie bomb.

### HOW DOES THE BRAIN BECOME A SALT JUNKIE?

Guanosine monophosphate is a flavour enhancer found in sauces and snacks. It intensifies other flavours, including saltiness. The problem: "We can become addicted to salt," explains Wolfgang Liedtke from Duke University in North California. In fact, salt unleashes a similar impulse in our brains to the one drug addicts have in relation to opiates and cocaine. The more salt we eat, the more salt the brain demands. Some ready meals also contain guanosine monophosphate to intensify their salty taste, meaning it's easy for us to quickly become addicted to pizzas, curries and the like.

### COULD A PLASTIC LID TRIGGER AN ATTACK OF HUNGER?

Phthalate is found in softeners for synthetic packaging, in foils, bags and lids. They're not firmly bound to the plastic, meaning the fabric can dissolve from a plastic lid and carry itself directly into the body. Many of the artificial compounds are chemically similar to the body's own hormones that trigger hunger. The brain becomes confused when these plastic materials alter the hormonal balance in the body. The hormones that tell a person when they are full are turned 'off' and a person begins to feel hungry.

### 61 CAN MICROBE-KILLING FAT CELLS MAKE ME CRAZY?

Tributyltin is found in anti-fouling agents, pesticides and preservatives. The substance is extremely toxic to microbes and fungi and is the reason why it's used in water supply systems and breweries, as well as in the production of plastic. If our bodies are exposed to tributyltin, the number of fat cells rise uncontrollably. These produce more and more hormones which send one message to the brain: "Feed me!" Bruce Blumberg, a biologist and cell researcher, explains, "Tributyltin encourages obesity."

### CAN TEFLON MANIPULATE MY METABOLISM?

Teflon (real name: polytetrafluorethylene) is often used as a coating for pots and pans. If you cook with these implements, you're consuming small amounts of Teflon in the process. In a study by the University of Exeter, blood samples from 3,000 people were taken and measured to check the levels of polytetrafluorethylene. The participants with the highest concentration of this chemical in their blood were twice as likely to suffer from an underactive thyroid, a slow heartbeat, depression or a decreased metabolism (which could lead to obesity).



### CAN FRUCTOSE TURN MY BODY INTO A FAT-STORAGE CENTRE?

Fructose occurs naturally in fruit, but is also found in sweeteners in diet products. The brain has a 'control station' in the body that determines what happens to the sugar we ingest. Glucose, for example, can be used to get energy or is converted into fatty acids. Fructose, on the other hand, can outwit the brain and its control centre. It is converted into fat and drives up the concentration of uric acid. The result: a poor digestion of sugar and other nutrients.

### CAN PLASTIC BOTTLES SWITCH OFF MY ALARM FOR OBESITY?

Bisphenol A is used in packaging for plastic containers, drinks and tins. The substance suppresses the hormone adiponectin which 'instinctively' protects the body from dangers like high blood pressure, bad cholesterol, diabetes and even obesity. The brain – and therefore the whole body – becomes confused as a result. Basically, by suppressing the hormone, which is important for controlling our weight, we can no longer decide which food is good for us and which isn't.

### DO ANTIBIOTICS MAKE ME FAT AS WELL AS HEALTHY?

Antibiotics are used to fight infections. They prevent the bacteria from multiplying as well as killing them off. The 'fighting substances' in the drugs are not picky – they also kill bacteria that are not harmful. The problem: researchers have found that a balance between 'good' and 'bad' bacteria is found in the intestinal flora. If an antibiotic kills many of the useful bacteria, damaging replacements can take root in its absence. This plays havoc with the regulation of hormones, which is in turn responsible for appetite and feelings of fullness.

### CAN MARMALADE MAKE ME ADDICTED TO CALORIES?

Cyclamate is found in diet drinks, desserts and spreads like marmalade. The sweet taste of this artificial sugar can trigger the over-production of insulin. The hormone causes our body to collect calories – and store them as fat! The problem: today we eat more sweet, cyclamate-containing diet products than ever before. This constant consumption means we reject products that are not so sweet. In the USA cyclamate has been banned for several decades – but that's not the case in Australia.

### WHAT HAPPENS TO MY BODY UNDER WATER?



### HOW DOES WATER ALTER MY SENSES?

Water plays havoc with our senses. You lose the ability to see clearly and to smell properly. Focus and contrast worsen because light is refracted underwater. Your hearing also becomes unreliable, because sound waves move five times faster in water than in air. It's difficult to tell which sounds are reaching the ear first, so you become disorientated, as noise seems to be coming from everywhere and all directions at once.

### DOES MY HEART BEAT IN SLOW MOTION IN WATER?

As your body enters the water, your heart switches to energy-saving mode. It drops its pumping rate, which is usually between 60 and 100 beats per minute, down to as low as 30 beats per minute. This is so that as little oxygen as possible is used up. Your heart knows that supplies of this life-giving substance are limited, and cannot be replenished underwater.

### HOW DOES WATER REPROGRAM MY KIDNEYS?

When in water, blood rushes from your arms and legs to the heart and lungs in order to keep those organs warm. This leads to confusion in your body: the extra fluid in the rib cage causes the heart to think that you've drunk too much, and so it orders the kidneys to produce more urine. The result? The urge to urinate when in water sets in far more quickly than it does on land.

### HOW MUCH AIR FITS IN MY LUNGS?

A healthy adult male can store about six litres of air in his lungs. That's enough to stay submerged for one to two minutes. Lung capacity can be increased, however, using what's known as the 'packing trick'. It works like this: breathe in deeply three times, sucking in air through your mouth. Then, use swallowing motions to squeeze the air down to your rib cage. Free-divers use this technique to store up to ten litres of air in their lungs.

### 71 CAN WATER BECOME CONCRETE?

Depending on weight and body position, a dive of just ten metres can prove fatal. When an adult dives from this height, they reach 40km/h and displace 75 litres of water on impact. If the jumper hits the water's surface either back- or stomach-first, they may as well be smashing into concrete. Injuries can range from bruising to serious bone fractures – or even worse.

### WHY IS SWIMMING MORE DIFFICULT THAN RUNNING?

When you swim, you use almost all of your muscles at the same time. Whilst your arms, legs and chest muscles move you forward, your abdominal muscles maintain your stability in the water. Swimmers also have to struggle against far greater resistance, because water is around 1,000 times denser than air. Swimmers exert more force and (due to lower temperatures) far more energy than joggers.

### **73** WHY DO SWIMMERS GET CRAMP?

The cold is a major factor. If the water temperature is lower than your 37°C body temperature, your blood vessels contract and restrict circulation. Water resistance also means that your muscles are subjected to greater pressures than normal. And if you haven't fully hydrated beforehand, cramps will set in, because your muscles require electrolytes and minerals such as sodium and potassium to function.

### WHEN DOES SEAWATER BECOME MY BODY'S ENEMY?

Guzzle too much saltwater while in the sea, and you'll die. Your body shuts down in a frantic attempt to expel the excess salt. It draws the water from the internal organs' cells, causing an increase in blood volume and a rise in blood pressure. The result: a fit, or even a heart attack.

### WHAT HAPPENS WHEN SOMEONE DROWNS?

When you dive into the sea, you're battling against your most important primal instinct: the urge to breathe. When your oxygen supply is cut off, the body starts a chain reaction that, after ten minutes at the most, ends in death...

### After 40 seconds

Your cells use up the oxygen supply, and replace it with carbon dioxide. These molecules flow into the circulatory system, putting your brain's respiratory centre on red alert. It orders you to take in more air.

### After 2 minutes

The concentration of oxygen in the blood has decreased by 15%. The brain turns itself off. The muscles go to sleep and the voice box opens. Water floods the lungs.

### Up to 10 minutes

The heart takes up to 10 minutes to use up the last remnants of oxygen in the coronary vessels. Then death occurs.

### 76 AT WHAT AGE DO YOU DEVELOP A FEAR OF HEIGHTS?

Standing on a glass floor whilst looking out of a 15th storey window would be nightmarish for many people – but not for babies. Why? Because humans don't develop a fear of heights until they start crawling, at six to ten months of age. As soon as babies can actively propel themselves forward, their brains start becoming aware of images on the peripheral visual field.

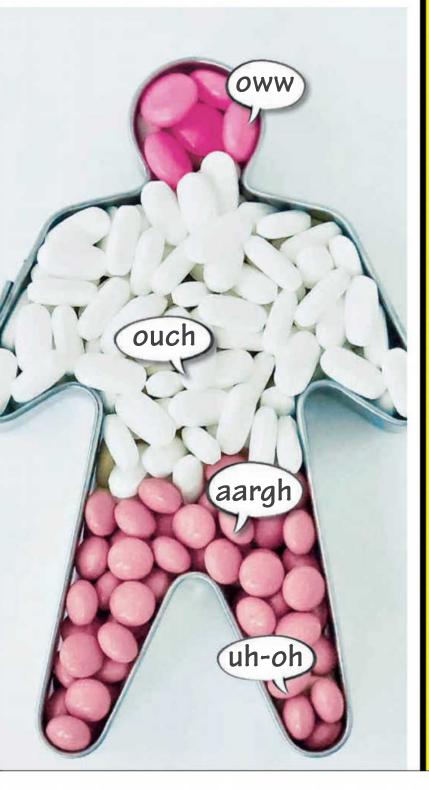
**77** 

### HOW DO PAINKILLERS KNOW WHERE I'M HURTING?

The most commonly taken painkillers are anti-inflammatories such as ibuprofen, diclofenac, naproxen or aspirin. These substances are chemically acidic. As an inflammation changes the pH value of the affected tissue, making them more acidic, these drugs accumulate there. They then inhibit the formation of the so-called mediators on site. These are endogenous, locally affecting messenger substances which trigger pain or strengthen it. They are important for the body because pain tells the brain that something is not right. As a result they set the corresponding endogenous healing process in motion. At the same time, however, the chemical messengers have effects that protect the intestinal tract, the kidneys or the circulatory system. If we suppress the process with a painkiller, we alleviate the pain, but under certain circumstances we can also cause side effects like gastritis, stomach ulcers or a higher risk of internal bleeding. In order to prevent long-term changes to the body and its protective healing mechanisms, painkillers should only be taken in exceptional circumstances. Similar painkilling drugs include paracetamol or metamizole, though they are less effective at combating inflammatory pain. Their exact method is unknown to researchers, but they seem to have an effect on protective hormones and are generally better tolerated by the stomach. Take paracetamol with caution because it can have a toxic effect on the liver. Always follow the dosage instructions on the packet, and do not exceed the RDA.

### When does my heart beat for the first time?

Four weeks after the egg and sperm cell meet, the developing foetus is 40 times the size of the original fertilised egg. It is on the 22nd day exactly that the cells that will grow into the heart muscle begin to pulse rhythmically. This early form of the heart is only a U-shaped tube two millimetres long – and is almost half the size of the entire embryo. At first only the blood is moved back and forth here. It's not until the fifth week that a proper circulatory system with directed blood flow forms.



### THE TIME CODES OF THE BODY

### HOW LONG DOES MY BRAIN NEED TO REACT?

The brain's nerve cells display impressive speed: it takes just 300 milliseconds – a third of a second – for a human to react to a visual stimulus. But the body actually works fastest when it's not using the brain. A pain stimulus (for example, when you touch the stove when it's on) does not go straight to the brain. Instead, it goes to the nerves in the spine. These cells instruct us to move our arm away from the source of the pain within 30 to 40 milliseconds.

### DOES MY SOCIAL NETWORK DETERMINE HOW OLD I'LL BECOME?

According to a study by the University of North Carolina loneliness has the same effect on life expectancy as regularly smoking cigarettes. People with a strong circle of friends live, on average, an extra 7.5 years compared to those with a poor social life.

### HOW LONG DOES IT TAKE FOR A PERSON TO REACH PEAK PERFORMANCE?

A minute after waking the brain is only operating at 67% of its potential and it can take up to 15 minutes for the brain to become fully operational. In the meantime, our performance ability is like that of someone with a blood alcohol content of 150 milligrams per 100 millilitres of blood – that's more than the legal drink-drive limit. Cognition, reaction time, coordination and decision-making all suffer until we are fully awake.

### HOW LONG DOES MY STOMACH NEED TO DIGEST FAST FOOD?

Does fast food live up to its name? Scientist Stephanie Barden asked test subjects to swallow tiny cameras followed by fast food – and homemade food as a comparison. The result: the homemade food took about 20 minutes to be almost completely digested, but the stomach took more than two hours (working at full capacity) to digest the fatty junk food.

### HOW MANY MINUTES IN THE SUN CAN MY SKIN WITHSTAND?

The 'intrinsic protection time' depends entirely on the individual, with the inner clock inside skin cells being determined by skin type, thus:

Type 1 (Celtic): fair, sensitive skin, red hair – 10-15 mins.

Type 2 (Nordic): fair, sensitive skin, blond hair – 20 mins.

Type 3 (mixed): light/medium skin, brown hair – 30 mins.

Type 4 (Mediterranean): dark skin and hair – 45 mins.

Type 5 (dark): dark skin, black hair - 60 mins.

Type 6 (black): black skin – 90 mins.

#### **84** WHEN DO THE MOST PEOPLE DIE?

Between nine and ten in the morning. It is the peak of the phase between 6am and midday, which is when 40% of fatal heart attacks happen. A protein called KLF15 is responsible for this – it is our heart's clock. In the morning hours it ensures an increased flow of potassium to the heart muscles, which raises blood pressure.

### HOW MANY DAYS DOES MY IMMUNE SYSTEM NEED TO FIGHT A COLD?

Regardless of whether you take medicine for it, your immune system requires seven days to successfully beat a cold.

### SECRET LIMITS OF THE BODY 89 HOW LONG CAN A HUMAN

SURVIVE WITHOUT FOOD? The hormone researcher Jerrold Olefsky

gives a person of normal weight about 60 days before they'd succumb to death by starvation - as long as they were ingesting water and the

**RESEARCH ON** necessary vitamins. During the THE EDGE starvation process the body Where do the limits of weight decreases by one our endurance lie? kilogram per day, and later by 500 grams. After a week Surgeons, neurologists the body starts to lose fat and psychologists reserves, while blood examine the maximum pressure and heart rate both limits of the human decrease. After two weeks body. muscle tissue (including the heart muscle) begins to atrophy

to provide the body with energy. Death from starvation occurs because of a lack of protein. IRA hunger striker Bobby Sands managed to survive 66 days, which is the very limit of what is normally possible. However, pathophysiologist Walter Siegenthaler carried out an experiment in which obese test subjects managed for 200 days without solid food. That's probably because every kilo of body fat provides a person with 10,000 kilocalories of energy.

**HOW MUCH BLOOD** LOSS CAN MY HEART COPE WITH?

Up to six litres of blood flow through the human body. You can afford to lose up to half of this, but any more than that and circulatory shock is a big risk. If the chemoreceptors in the blood vessel walls register a major leak in the body (around 2.5 litres of blood lost), a self-preservation trick kicks in: it places the body in a state similar to hibernation and dials the core temperature down to 33°C so that less oxygen is used up. That's why people suffering blood loss are freezing, even in tropical temperatures. At the same time the body pumps the remaining fluid through the circulatory system with increased speed. After a blood loss of three litres, only the most important organ - the brain - is supplied with oxygen. Not long after, it's all over.

### **HOW FAST CAN** A HUMAN RUN?

We seem to be near the limit already. While sprinter Usain Bolt has travelled a 100-metre stretch in just 9.58 seconds, biologist Mark Denny predicts that in the future a human could bring that down to a maximum 9.48 seconds. That's equivalent to 37.7km/h.

#### **HOW LONG CAN MY KIDNEYS FUNCTION WITHOUT WATER?**

Water is the most important component of our bodies: in fact about 63% of our body consists of the water that is continually coursing through us. Only when it is dissolved in water can our blood transport oxygen and other vital substances to the kidneys. "The kidneys are like a highperformance lab," says Professor Gerhard Mueller. They flush 1,800 litres of blood per day, getting rid of waste products and medicines in the urine. The kidneys even continue to work tirelessly when 15% of our body's water content has been lost (equivalent to 72 hours without liquid). "The heart has to use extra pressure to pump the ever-thickening blood to the kidneys for flushing," explains Mueller. After five days, at the latest, the person will fall into a coma. Biological death would follow shortly afterwards as a result of kidney failure.

#### **HOW HIGH CAN WE JUMP?**

The current world record is 2.45 metres. The record holder: Javier Sotomayor. The Cuban has collected six world record titles and is the most successful high-jumper of all time. The most important body part for the high jump is the Achilles tendon. It takes on some of the acceleration and body weight from the heel. During record-breaking jumps, forces of up to 14,000 Newton (N) affect the tendon. Experts believe that up to 18,000N would be possible before it would tear. Theoretically, that means a human could jump up to 3.15 metres high.

#### **HOW DEEP CAN** A PERSON DIVE?

Professional free-divers - they dive without compressed air tanks - go to the limits of what is possible. In 2007, Herbert Nitsch dived to a depth of 214 metres and back to the surface again in four and a half minutes on just a single breath. Five years later, attempting to go deeper than 253 metres, Nitsch blacked out and required extensive decompression treatment. The depths that future divers could reach divides opinion. Scientist John Fitz-Clarke believes that they could reach depths of 300 metres. But his colleague Neal Pollock believes Nitsch's record dive is the limit, since the lungs would collapse under the enormous pressure at greater depths.

#### 92 HOW MANY COLOURS CAN I SEE?

A tetrachromat is an organism with a distinctive super sense: it can see 99 million shades of colour. Normally a person perceives only 500,000 true colour sensations. But as a result of a genetic defect, the eyes of some people have four types of colour receptors instead of three, similar to some insects and spiders.

### **HOW MUCH CAN I REMEMBER?**

Our brain is like a super-calculator: it consists of around a billion cells which each build around 1.000 connections to other cells. This dense network possesses a storage capability of 2.5 million gigabytes - in theory we could remember everything. But there's a problem: even though our storage capacity is sufficient, our brain lacks the ability to recall everything. In other words, we have difficulties remembering.

#### **HOW MANY DECIBELS CAN** MY EARDRUMS COPE WITH?

90dB is where things get dangerous - equivalent to the sound of a lawnmower. Our ears are not equipped to cope with this volume for more than an hour. The use of headphones with a volume over 100dB can lead to hearing damage in just five minutes. At 110dB, the volume of a jackhammer, the limit is just 30 seconds. Everything above 120dB, like gunfire or a jumbo jet taking off, lies above the pain boundary and can lead to serious hearing damage almost immediately. The loudest sound ever measured was registered during the Krakatoa volcano eruption of 1883 the blast measured 180dB even at a distance of 160 kilometres.

### 95 HOW QUICKLY CAN YOU ACCELERATE AN ORGAN?

Tests using a high-tech crash test dummy have shown that in a head-on collision at 50km/h, it's mainly the liver that can accelerate unrestrained against the ribs. In spite of this, many accident victims are able to walk away from their cars unhurt. How does that work? Our organs are covered in a protective network of fascia. They are part of our connective tissue and act as a kind of shock absorber. "A healthy fascia is constructed a bit like a pair of women's tights," says connective tissue expert Thomas Myers. "The latticework grid means even the strongest accelerative forces are pushed in many directions without tearing."

Among scientists, marijuana (and, in particular, its active ingredient THC) is one of the most controversial substances with regard to its long-term effects on the body. While some studies claim that THC can even have a carcinogenic effect, other researchers warn of the raised risk of psychosis or a decrease in IQ as a result of marijuana. On the other hand, the short-term effects of cannabis on the brain are undisputed. They start to occur just seconds after THC has been consumed.



### 97 CAN OUR BODIES GENERATE ELECTRICITY?

Our bodies are brimming with energy: on average a person's fatty tissues store the energy equivalent of 390 megajoules (93 million calories). What if you were able to tap into this energy? Thad Starner from the Georgia Institute of Technology in the US did just that – and used it to run portable technology. He managed to achieve 76 watts, enough to power 30 smartphones or a laptop.



### How much information can a brain hold?

The human brain is composed of roughly 100 billion nerve cells known as neurons. Every neuron has around 20,000 synaptic connections to other neurons. Assuming that every one of these connections is equivalent to a computer bit, the brain possesses a storage capacity of between 100 and 1,000 terabytes. That's the same information capacity as 500 million books.

## 206

### 99 HOW MANY BONES DOES A HUMAN HAVE?

Every healthy person has 206 bones. Babies initially have over 270 bones, but as they grow, some fuse together. Our bones make up 14% of our body weight. Tendons, muscles and cartilage connect our bones to the skeleton. The most important bone is the spine – it holds all parts of the skeleton together

and gives our body its elasticity. Twenty-four vertebrae are found in our back, held together by six strong ligaments, the spinal discs and countless muscle groups. The spine keeps us upright and can withstand trauma better than the shock absorbers on a truck.

### HOW DO YOU RECOGNISE BLOOD POISONING?

### DR MARTIN BRUNKHORST

is an expert in septicaemia and explains here why blood poisoning is so dangerous.



### Blood poisoning is one of the most common causes of death in Australia. Is that correct?

Yes. Every year, over 30,000 people are admitted to hospital with septicaemia. Around 7,500 will die as a result of the condition. Only cancer and heart attacks pose greater dangers.

#### Who is most at risk?

The very young or very old, people taking steroids, anyone undergoing chemo or radiotherapy, and those suffering from long-standing diabetes, pneumonia, meningitis, cirrhosis or AIDS.

#### How can I recognise blood poisoning?

You may have a high temperature, often accompanied by chills and severe shaking. Sometimes, though, your body temperature may be a little lower than normal at around 36 degrees. You may also feel dizzy, confused or disorientated.

#### Fever, chills - that sounds like the flu...

That's the biggest danger. Blood poisoning is so insidious because it presents itself in a very similar way to harmless diseases like a stomach bug. It's only in rare cases that a doctor would think of blood poisoning.

### How does a person contract septicaemia?

A scratch, an insect bite or a burn are enough. In many cases the trigger is a lung infection contracted as an outpatient.

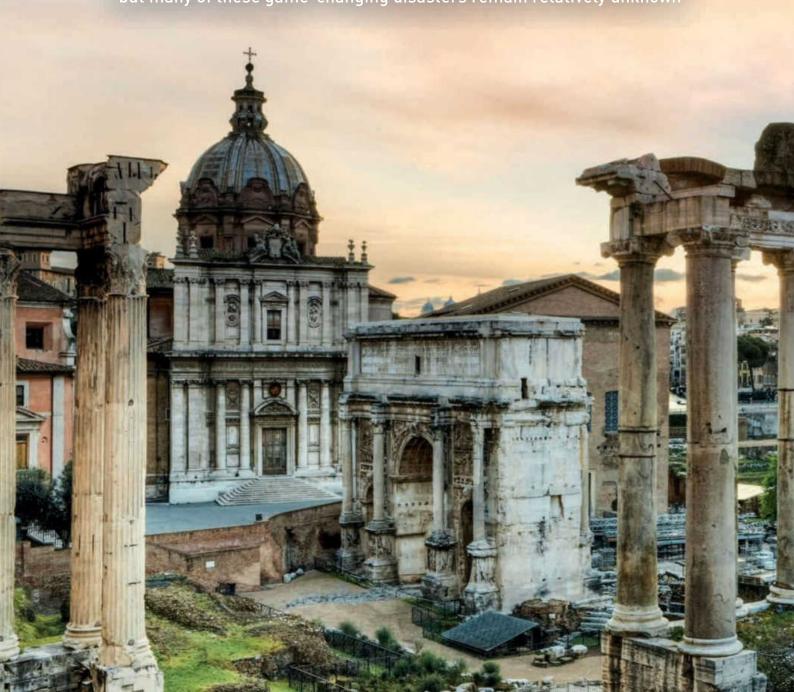
### What's the fastest way to confirm blood poisoning?

Using the procalcitonin blood test. If the illness has taken hold, the level of procalcitonin in the blood increases up to a thousandfold. If your GP suspects you have blood poisoning, they should admit you to hospital right away. Then the test can be administered and the results evaluated as soon as possible. Blood cultures also need to be taken to ascertain the exact pathogen. The results of this diagnostic test can be expected in 24 to 36 hours. Before then, broad-spectrum antibiotics are prescribed as they catch most pathogens.

HISTORY

# HISTORY'S SECRET CATASTROPHES

They have cost countless human lives, toppled empires, ruined ecosystems - but many of these game-changing disasters remain relatively unknown





## Was the Roman empire toppled by an ICE AGE?

ome in the year 400. The empire's lustre, once something that brought the rest of the world to its knees, is fading. There are still Roman garrisons on the border with Scotland and on the banks of the Nile. But the legions are weary, there is constant in-fighting among the ruling powers. It's been five years since the empire split in two - into the eastern and western parts. And it is the beginning of the end, an outcome that is advancing much more quickly than anyone could have anticipated. In the year 410, Germanic tribes invade the empire and manage to conquer its capital. But behind this downfall of an empire, there's a more complex story - a force more powerful than humans. A silent natural disaster is overtaking Rome.

When the Germanic tribes leave their homeland, it's not just the departing warriors, but entire villages: women, children and the elderly. Forced to leave because their crops have failed, families transport their entire lives on their backs.

In reality this mass exodus of people is an example of

"Rome has fallen. The city that previously ruled the entire world."

> SAINT JEROME (347–420), Scholar and theologist





THE LAST
EMPEROR
Romulus
Augustulus
[shown above
on a coin] was
the last Roman
emperor. After
his removal
from office in
476, the western
Roman empire
effectively
became
defunct.

climate-induced migration. Analysis of bones in Danish peat bogs proves the people were suffering from years of famine after a period of extreme drought and freezing cold temperatures. Harvests fail, animals die out, diseases spread - and rivers freeze over. For Rome, it is a catastrophe. The rivers are a natural barrier protecting the empire from these sorts of economic migrants. For the Germans, it's a stroke of luck. In the year 406 alone, more than 80,000 people use the frozen Danube and the Rhine to gain safe passage to the south. This exodus is accelerated by the invasion of the Huns in Eastern Europe.

Rome is helpless. While in the north the Vandals, the Alans and Suebi are ravaging Gaul (the area now occupied by France, Luxembourg and Belgium), the Visigoths are rising up in the east. But the Roman emperor refuses their demands for fertile land. As a result, the Visigoths advance towards Rome - the Senate panics and offers to buy them off, but this isn't enough for the Visigoths. Rome falls and is looted. For the empire, it is the beginning of the end.

## Which treaty sealed the **FATE** of the world's oceans?

f it were a state, there would be enough space to house all of the world's 193 countries. The planet's oceans, which are officially considered non-territorial waters, cover an area of around 300 million square kilometres. No nation has precedence here; there are no laws, other than those that apply to seafarers. Here the freedom of the individual is almost without limits. But it's this very freedom that is becoming the oceans' downfall. A man-made

disaster is now destroying the biggest habitat on Earth. And it was a treaty that allowed it to happen in the first place.

The United Nations
Convention on the Laws of
the Sea (1982) decreed that
all parts of the world's oceans
more than 320 kilometres
from the mainland were
ownerless and therefore
beyond the reach of the law.
This means the residents of
this no-man's land are the
property of anyone who cares
to fish them out of the water.



MEANINGLESS DEATH A conventional net can't differentiate between what lands inside it: up to 80% of the catch is not commercially viable and the lifeless victims are thrown back into the sea. A tax-free source of income that attracts fishermen the world over. It's like a treasure chest – and every country has a key. The result is a free-for-all, with every country desperate to acquire as much of the bounty as they can. "Too many boats are chasing too few fish," is how Greenpeace summarises the problem. New technology that helps track large shoals of fish and bigger trawlers are only exacerbating the problem.

In the meantime, threequarters of commercial fish



stocks are overexploited, endangered or have even been depleted entirely. But even turning the world's oceans into a nature reserve like Antarctica - as some marine biologists are now calling for - would have negative effects. An economic earthquake would be unleashed: every year around 100 million tons of food is pulled from the world's oceans, and over 200 million people around the world earn their living as fishermen. When Canada banned the fishing of cod for its protection, 25,000 people found themselves jobless. And yet cod stocks still haven't recovered.



## How many **NUCLEAR POWER STATIONS**have really exploded to date?

wo places have gone down in history in connection with nuclear disasters: Chernobyl and Fukushima. They secured their notoriety because the authorities couldn't cover up what happened. In reality, though, there are many more instances of a similarly explosive nature.

Hardly anyone has heard of the Russian city of Kyshtym in the southern Urals. What was kept quiet from the rest of the world was that on 29th September 1957 a huge explosion ripped open the ground close to the city. Over the following 25 years, the Soviet government has been declassifying documents that reveal the thirdbiggest nuclear catastrophe in history occurred at the Mayak

Local Vadim Guschtschin remembers the exact day of the disaster: "The radioactive cloud rose a kilometre above the site of the explosion, which was lit up red. The leaves on the birch trees immediately turned yellow and fell to the ground. Within a very short time, the forest offered a terrifying

power plant, near Kyshtym.

sight." The public weren't told anything about the accident at the plant, which is where the plutonium for the first Soviet atom bomb was being produced. What actually happened was the cooling system in an underground tank containing radioactive waste failed. The waste then began to

heat up and eventually exploded. Twenty million curies of radioactive material was hurled into the sky, where it was scattered up to 400 kilometres by the wind. This became known as the East Urals Radioactive Trace (EURT) and is still evident today. "Hundreds of people died and tens of thousands were affected by radioactive

To date, there have been some 34 incidents at nuclear power stations where at least one person has died. But those responsible have shown worryingly little interest in clarifying the facts: after all, the positive reputation of an important technology

contamination," claims Zhores

the catastrophe.

is at stake here.

Medvedev, who has researched



RESTRICTED ACCESS The nuclear power plant of Mayak is still in use today, but the entire area is restricted.



49

## Has there ever been a case of MANMADE CLIMATE CHANGE?

ohn Lloyd Stephens is sweating heavily. He has barely slept for the last few days, so feverish with excitement is he about his discovery. During an expedition in 1839 he stumbles across a pyramid in the Mexican jungle. There's also an aqueduct and a temple decorated with writing. It has to be the work of a civilised society - one that has lain undisturbed for centuries. As US ambassador, Stephens knows the country well. Most natives are illiterate and live in poor conditions. Who were the builders - and where did they disappear to? What Stephens doesn't know is that the ruins represent the vestiges of the first instance of a manmade climate catastrophe.

Before Mayan culture disappeared in the space of just a few decades in the 9th century, it had existed for 3,000 years. It reached its zenith in the 6th and 7th centuries. But 200 years later the climate suddenly changes – a drought begins. Years pass with little or no rain, resulting in failed harvests, famine and conflicts.



OUT OF KILTER The further the Mayan civilisation developed, the more the population grew. Experts believe that 12 million people needed to be fed by the end of the 9th century. During this time the Mayan empire stretches across an area the size of Victoria and Tasmania put together. Cities have up to 50,000 inhabitants. To counteract the lack of food, the Mayans do what civilisations have always done: they uproot entire forests, enlarging farming areas and increasing their crop yields as a result.

But the rapid deforestation exacerbates an already severe drought. The soil is exhausted and the deforested areas reflect more sunlight – a domino effect that is enough to bring the sensitive climate to its knees.

Tom Sever, NASA's only archaeologist, explains: "As a result of the deforestation, the temperature rose by five degrees - in the same period, rainfall decreased by a third." The consequence: a 100-year super drought. And this leads to food shortages and political unrest. Population numbers rapidly decline cities become ghost towns. In the end, the homemade climate crash wipes out a sophisticated, engineering-led culture with its own written language. All traces of the Mayans vanish – until John Lloyd Stephens begins digging up their cities again.





Can one **DRUG** turn the whole world into addicts?

<sub>12</sub>H<sub>22</sub>O<sub>11</sub> is a hard drug; like cocaine, alcohol or nicotine, it stimulates the reward centre in the brain to such a degree that a human can become dependent on it. But we're not talking about an illegal substance here. The drug in question is sucrose - better known as sugar. "Our fondness for sugar is in our nature," says David Benton, professor of psychology at Swansea University, UK. If the necessary dose is not reached, people display withdrawal symptoms. But could a substance that is freely available in every supermarket actually be the cause of one of the biggest catastrophes in history?

In the Middle Ages the white crystals are virtually unknown in Europe - by the 1800s it is considered a luxury good from the tropics, surpassing even gold. But then Prussian scientist Franz Karl Achard discovers a method for cheaply producing sugar that makes the drug accessible to all income brackets. Within 150 years the use of the substance increases 150-fold. Achard lays the foundation for a new industry with ready-made customers: every year the global sugar trade brings in around \$70 billion. On average, every Australian consumes around 40kg of the legal high a year.





SWEET POISON 100 grams of these sugary shoelaces contains 60 grams of sugar.

But the addiction to sweet things is making us ill.

"Sugar is a poison," explains Robert Lustig from the University of California. "Too much leads to obesity, heart disease or metabolic problems." The consequences of obesity alone causes 2.6 million deaths a year worldwide. There's no maximum limit placed on sugar, and that comes down to the widespread acceptance of the drug - similar to that once enjoyed by tobacco. Health expert Imre Loefler declares: "Sugar is as dangerous as tobacco and, where world health is concerned, much more significant. It should be reclassified as a hard drug."



azakhstan, 1954
the people still
living in the
steppes north
of the Aral Sea
are poor. For
decades there's been hardly
anything to eat – hundreds
of thousands of people have
already starved to death.

So when the Soviet government implements a wide-reaching agricultural program, they are pursuing honourable goals: they want to turn barren areas into arable land - a green revolution! No factories and no roads. Instead, the funding of agricultural structures on the ground should bring wealth to the region. There is only one problem. In order to cultivate these great swathes of land, an important - but missing - ingredient is required: water. But the

Using canals and dams, water is siphoned off from the Amu Darya and Syr Darya rivers that supply the Aral Sea. It works – but what is thought of as sustainable agriculture turns out to be one of the most serious manmade catastrophes of the modern era.

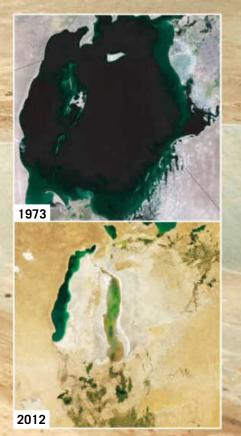
The interference into the region's natural water management is too great. In the space of 50 years the Aral Sea shrinks from 70,000 square kilometres to just 14,000 square kilometres - in the same time period the volume of water decreases by 90%. Where once fishing fleets went about their business and thousands came to bathe, there is only dry land as the lake begins to transform into a hostile salt desert. The salinity of the Aral



**DEVASTATION** OF A LAKE 50 years ago the Aral Sea was the fourth-biggest inland lake in the world - with beaches, fishing boats and hotel complexes. Today it is a hostile salt flat that cannot sustain life, roughly the size of Tasmania.

Sea increases from nine grams to 150 grams per litre of water. The vast majority of animals and plants die. And, as a result of the salinisation of the lake, the original plan for the surrounding areas is abandoned: more than 550,000 hectares of arable land becomes unusable. For the people who live there it is a disaster.

But the long-term consequences are even more dangerous – for the whole of humanity. Because in the bone-dry soil of the salt desert, highly toxic substances remain, even after the water disappears. For decades, artificial fertilisers and pesticides have been sprayed on the cotton plantations along the



POISON FACTORY Satellite images illustrate the extent of the catastrophe. Today the winds carry dust from the pesticide-soaked lake floor all the way to the polar regions.

rivers that empty into the Aral Sea. And after the devastation of the steppe, wind carries 100 million tons of poisonous dust into the stratosphere every year. A process that is responsible for 5% of global air pollution.

The Aral Sea's poisons have been distributed across the world. Pesticides from the area have even been found in the blood of Antarctic penguins. The health statistics from the Aral region prove just how dangerous these contaminations have been for the area's inhabitants: stomach and intestinal illnesses, as well as respiratory diseases, have seen a sharp increase - in some cases up to 30-fold. Cancer rates have also increased. Child mortality is 400 times higher than in Russia. Many experts today liken the Aral Sea catastrophe to the nuclear disaster in Chernobyl.

### Which natural disaster almost WIPED OUT THE HUMAN RACE?

he history of humans on Earth has run a pretty straight course. But DNA researchers have now discovered something extraordinary: in reality humanity has been faced with extinction at least once.

The most dramatic moment for our species happened roughly 73,000 years ago. That was when the super-volcano Toba, in modern-day Indonesia, exploded. It was the most powerful eruption of the last two million years on Earth, producing 2,800 times more ejecta than Eyjafjallajokull, the Icelandic volcano that threw Europe into chaos in 2010. Ash darkened the atmosphere, causing temperatures in some places on Earth to plummet 18 degrees. A lack of rain also caused major droughts. Only a few thousand members of Homo sapiens survived.

"At that time the whole of mankind could have fitted into

a single concert hall," explains geneticist Spencer Wells. He and his colleagues from the Genographic Project have so far compared the DNA of 700,000 people from 140 countries and confirmed that every human currently alive originated from this

> group, which was living in Africa at the time of the explosion. "For us the DNA is a historical document," explains Wells. "And it shows that we are all Africans and our genetic differences are purely external."

> The DNA of our ancestors can be chronologically and geographically traced back thanks to a molecular

clock. The genome undergoes spontaneous changes roughly 100 times per generation.

Scattered ash from the disaster can still be found in parts of the world today. The volcano itself disappeared: in its place there is now a 90-km-long lake.



**POWERFUL ERUPTION** The Toba volcano threw ash particles up to 80km into the air, almost into space.



### Which disaster claimed the **MOST LIVES**?

t is the third-strongest quake ever recorded: on 26th December 2004 a jolt in the Earth's crust beneath the Indian Ocean unleashes an immensely powerful tsunami that claims a quarter of a million lives across Asia and Africa. The Sumatra-Andaman quake is considered a once-in-amillennium catastrophe - but it doesn't deserve this title. That's because, 73 years prior to this, up to four million people lost their lives to a body of water in China. Excluding famines and pandemics, this flood is

probably the most severe natural disaster of modern times – yet today, the event is almost entirely unknown.

All hell breaks loose in 1931 when central China is hit by nine cyclones in the month of July. Usually, there are just two per year. Following the severe storms, China's three largest rivers break their banks – one of which, the Yangtze, briefly becomes the most powerful river on Earth with an average width of 65 kilometres. Some 110,000 square kilometres of land are flooded. But the real catastrophe is yet to come: for while a flood normally



CHINA'S LIFELINE Measuring 6,300 kilometres, the Yangtze is the thirdlongest river on Earth after the Nile and the Amazon. A third of China's population live along its banks. lasts only days or weeks, this time the water remains for six months. The river drowns crops on vast stretches of land, turns hills into islands and streets into waterways.

Around 80 million people go hungry. Survivors turn to violence and cannibalism. In China, the shock that the catastrophe caused is still deeply entrenched – it was the real reason behind the construction of the Three Gorges Dam on the Yangtze: not the 98.8 billion KWh of electricity it provides, but the flood protection. The tragedy will never be allowed to happen again.



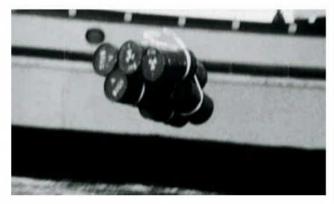
## How dangerous is a **NUCLEAR WASTE DUMP** in the sea?

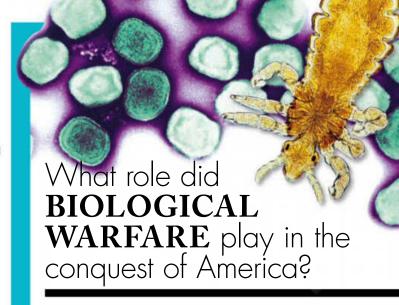
adioactivity only decreases, it never disappears completely - it's a problem with far-reaching consequences. By the end of the century, the UK will have around 300,000 cubic metres of the most toxic type of radioactive waste to dispose of. But the far bigger problem isn't found in the vaults at Sellafield, where the country's atomic waste is currently stored - but on the floor of the North Sea. That's because between 1950 and 1963. the UK and Belgium simply sunk their nuclear waste at sea. According to a table by the International Atomic Energy Authority (IAEA), the radioactivity packed into the containers amounts to 42,320 terabecquerels. By way of comparison, in the first few days after the Fukushima explosions, about 0.2 terabecquerels were released into the air. A ticking time bomb is lying on the seabed off

the coast of Europe. Experts had assumed that the containers rusted open years ago, allowing the nuclear material to dissipate harmlessly. But in 2013 a team of French and German journalists discovered barrels of radioactive waste at the bottom of the sea, just a few kilometres off the French coast. In total, 28.500 metal containers reinforced with cement or concrete were rolled into the waves. Many ended up 140 metres below the surface in Hurd's Deep, a deep underwater valley in the English Channel. Concern over radiation levels in the nearby island of Alderney is such that fish, shellfish, sea water and sand are tested on an annual basis.



PHOTOGRAPHIC EVIDENCE This image from the 1960s shows the waste containers marked with a warning sign being sunk in the Channel.





hen the
Aztecs find
out about the
Conquistadors, they are
thrown into a state of fear
and desperation. "They
have weapons made
from iron, wear full-body
armour and giant staglike animals take them
wherever they want to
go," their messengers
warn them.

For centuries, a legend does the rounds that the 150,000 Aztecs in the capital city of Tenochtitlan were defeated by just 663 Spaniards.

But in reality, it isn't the firepower of the Spanish guns that proves decisive. It's a single man who triggers a catastrophe and kills more opponents than all the weapons combined.

The Spaniard, whose name is not known, was carrying a biological bomb: smallpox, a highly contagious virus – and one completely new to America. Many of the Spanish have immunity against it, but for the

natives an infection means death in a third of all cases. In the space of a year, around 40% of the Aztecs die and the remainder are left feeling weak. But instead of isolating the sick, they try to liberate themselves from their sins through communal bathing – which only encourages

the further spread of the virus.

"In less than a century 90% of South America's original indigenous people were wiped out," explains ethnologist Ursula Thiemer-

Sachse. Never before has an advanced civilisation died out so quickly.

The Spanish also use a sneaky tactic against the Native Americans, offering them blankets contaminated with smallpox. In fact, you could says that in 18th century America, smallpox was the biological weapon of choice.



EUROPEAN BIO-WEAPONS Imported diseases eradicated 90% of Native Americans.







ooper steers the spaceship directly into the huge, jet-black hole. Thousands of lights circle around the object, but he only perceives them as a single glimmering strip. The lights grow more intense until the ring becomes as bright as a star. Cooper flies straight into the dark centre. He finds himself inside a tunnel where thousands of lights shoot past him. This scene, from the film *Interstellar* is, currently, just a flight of science-fiction fantasy.

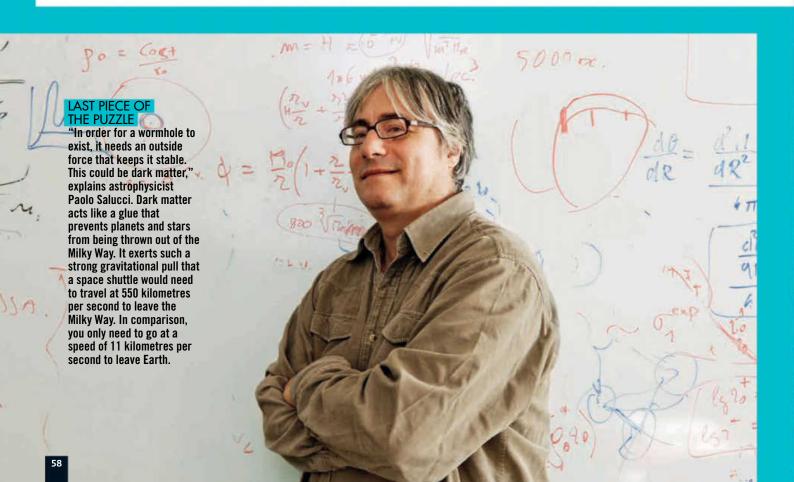
"But a wormhole could work just like in the film," says Paolo Salucci, an astrophysicist at the International School for Advanced Studies in Trieste, Italy. "According to our latest findings, the whole Milky Way might be a space-time tunnel. It's also very stable and navigable."

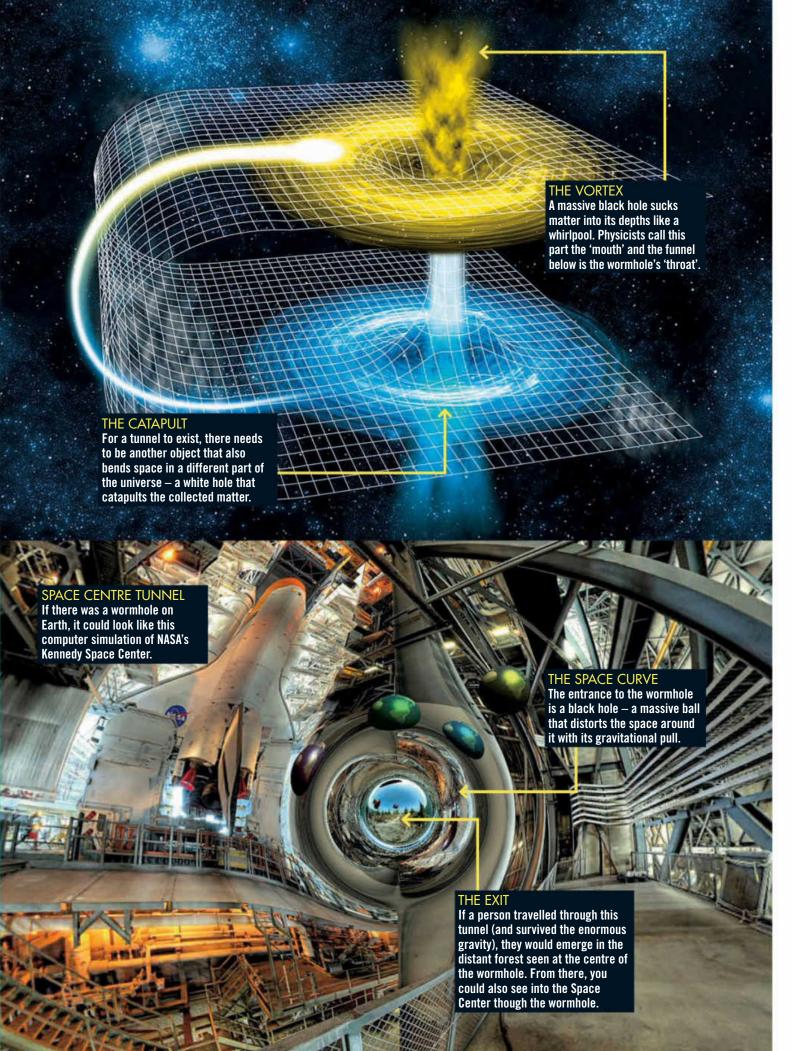
A wormhole, also known as a space-time tunnel or an Einstein-Rosen Bridge, can be imagined as follows: suppose we have a map of Australia. If you want to travel from Sydney to Tokyo, you can follow the route on the map. For us, the shortest route would be in a straight line. But, if there was a wormhole, we'd be in Tokyo in less than a second. For this to happen, space would have to be curved: we fold the map so the two locations sit directly on top of each other. Now we poke a pencil through Sydney so the tip comes out in Tokyo – a shortcut in the form of a space-time tunnel. In space, you need three ingredients

to 'build' a wormhole: black holes, white holes and dark matter.

### HOW IS A WORMHOLE CREATED?

Ingredient 1: Black hole. It begins with the death of a giant star. After millions of years, its core runs out of nuclear power - and implodes. The star collapses in on itself because it can no longer withstand its own gravity. A mass equivalent to ten suns is compressed to the size of NSW. This dense ball of matter has such a strong gravitational pull that even light can't escape it - the object becomes a black hole. Next, it begins attracting more and more matter - it 'eats' any surrounding stars from the inside out to feed itself. The black hole finally reaches its 'saturation point' when it has swallowed everything nearby. But it still operates like a gigantic cosmic hoover: if a star, planet or asteroid comes too close, its incredible





force pulls it into its dark heart. The black hole can be thought of as a sphere, with a funnel behind it.

#### Ingredient 2: White hole.

Astrophysicists are convinced that white holes form in another part of the universe. They work as follows: like their opposites, black holes, they consist of a spherical opening and a funnel. The difference is that here, matter is drawn out and ejected. A white hole doesn't attract, it repels. It even pushes light away, which is why it emits a very bright light, like a huge cosmic torch. Some scientists theorise that these white holes randomly connect with black holes. Others, like Nikodem Poplawski from Indiana University, suggest that two particular holes always come together, because their gravitational forces complement one another. Whatever the case, the result is that these forces bend space. They fold it as we would a map [see graphic on previous page].

This curvature of space is caused by the matter's gravitational pull: to

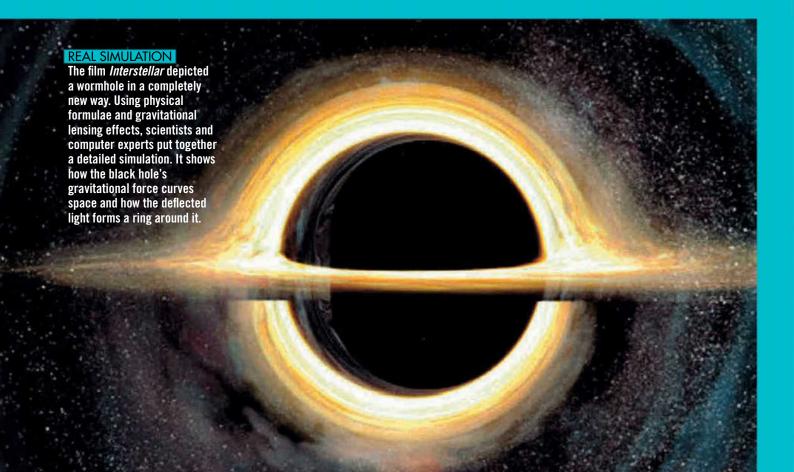
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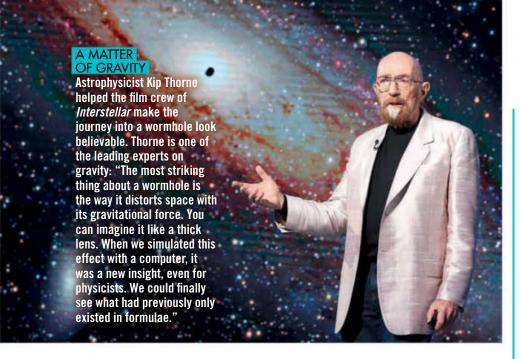
Without dark matter, our galaxy would fall apart. It's the cosmic glue that holds the stars and planets together. It's so strong that it could even stabilise a wormhole.

FREDERIC BOURNAUD, ASTROPHYSICIST

understand this, let's imagine a large piece of kitchen roll with an egg in the middle. Now we carefully lift up the four corners of the paper. What happens? The weight of the egg forms a gully. This shows us how matter's mass can bend space (or here, the kitchen paper). It's like this – only on a cosmic scale – that a supermassive black hole deforms

space like a gravitational monster. But astrophysicists have a problem: the gravitational pull that could create a tunnel through the bent space would also destroy it within seconds. The gravity at the point where the funnels of the white and black holes meet would be so strong that the tunnel would collapse in on itself.





Unless, of course, there was an opposing force...

#### Ingredient 3: dark matter.

For a long time, experts believed that a wormhole could only exist when matter counteracted the negative gravitational force. "We couldn't prove that such a substance existed. But we now know about a substance that could fulfil this function: dark matter." explains Paulo Salucci. It's still a mystery what dark matter actually is and, until now, there have only been theories. But it is a fact that without dark matter, and its gravitational pull, our galaxy would fall apart. So logic dictates that it must exist. Using the mass and rotational speed of the Milky Way, astrophysicists have calculated how much of the mysterious dark substance the galaxy contains. "According to our most recent observations, dark matter makes up 95% of all matter in our galaxy and can also be found in large quantities far from the visible Milky Way's stars, planets and dust. This means that our galaxy is actually 50-60% larger than we originally thought," says Salucci. "But our most important discovery is that dark matter is an important factor in the construction of space-time tunnels. It could be the substance

that counteracts the gravitational force of the black hole from the outside – keeping the wormhole stable and open."

Astrophysicists from the University of Oldenburg are convinced that, if a type of matter could stabilise a wormhole, it could assume gigantic proportions – and grow to dimensions that physicists describe as 'arbitrarily large'.

"We believe that the tunnel could exceed a diameter of 30,000 light years, which is more than the inner region of our galaxy," says Salucci. "And that means that the entire Milky Way, no less, could be a tunnel or a galactic transport system. Earth would also be a part of this."

If you look down from the top of the galaxy, there are certain similarities to the entrance of a wormhole: in the middle, there's a supermassive black hole surrounded by an intense ring of light. The arms of the Milky Way are also spiralled, effectively acting like a vortex that flows into the black hole.

### WOULD A PERSON BE RIPPED APART IN A WORMHOLE?

This theorising leads to an obvious question: if our Milky Way is

a tunnel, why haven't the Earth, and all the other planets that orbit the sun, been sucked in? The answer's simple: we're 26,000 light-years away from the black hole – a distance too great for it to draw us in. But could people travel through the tunnel if we reached the centre of our galaxy?

"If dark matter stabilises a space-time tunnel, then it's possible," explains Salucci. But this is only true if we can build a spaceship that could withstand the immense pressure: that's because, inside a black hole, the gravitational force is far stronger than outside. The vessel would also be stretched like a rubber band – a process known as 'spaghettification'. The gravity would eventually pull everything apart, right down to the individual molecules.

If engineers could resolve this issue by, say, carrying an amount of dark matter as a counter force, we could travel through the space-time tunnel to another region of the universe. A return trip wouldn't be possible, though: as the exit is a white hole, we couldn't get back in, because it repels. A wormhole would a one-way trip.

### COULD ADVANCED CIVILISATIONS BUILD WORMHOLES?

An even more mind-boggling proposition, one that's been put forward by astrophysicist Kip Thorne [see photo above], who advised on the sci-fi movie *Interstellar*, is that wormholes cannot occur naturally, and therefore must be created. He says: "I came to realise that if they [wormholes] did exist, it would not be hard for a very advanced civilisation to use a traversable wormhole to make a time machine."

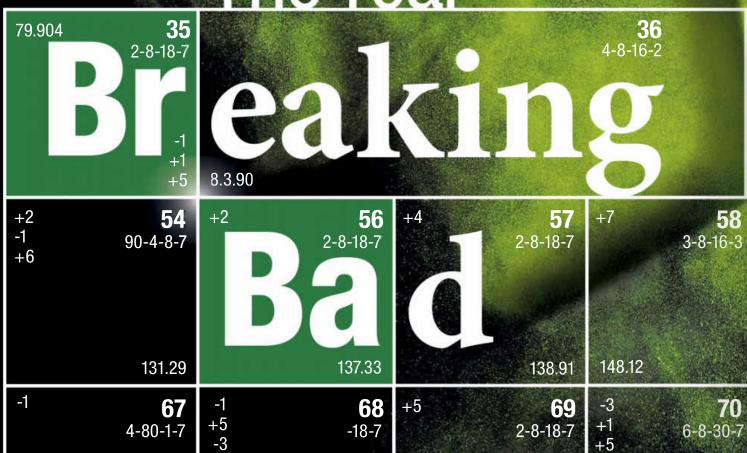


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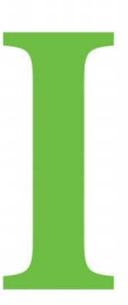


Breaking Bad's Walter White [above] became one of the most ruthless drug lords of all time. But if you thought the fictional TV character's story was far-fetched, you reckoned without a college graduate called Ross Ulbricht. The big difference between them? Ulbricht's story is 100% true

### The real



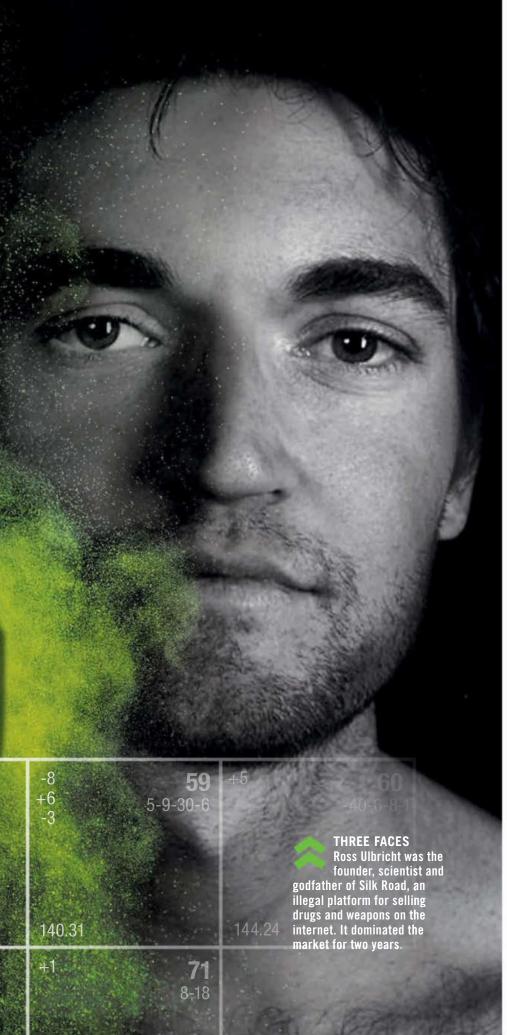
## **WORLD EVENTS**



t's not every day that you pick up a newspaper and find out that your housemate has been living a secret double life. "Giant online drug ring discovered, operator suspected of murder" screams the headline in the San Francisco Enquirer. Brandon laughs, takes a picture of the front page on his smartphone and sends it to his roommate Drew: "Funny, this guy looks like our next door neighbour." The reply comes almost immediately - and wipes the smile off his face. "It doesn't just look like him. It is him."

#### **CAN YOU CREATE A DRUG CARTEL WITH A LAPTOP?**

The sun is shining in San Francisco. It's the day that Dread Pirate Roberts ceased to exist. Under this pseudonym, Ross Ulbricht controls a global empire called Silk Road,

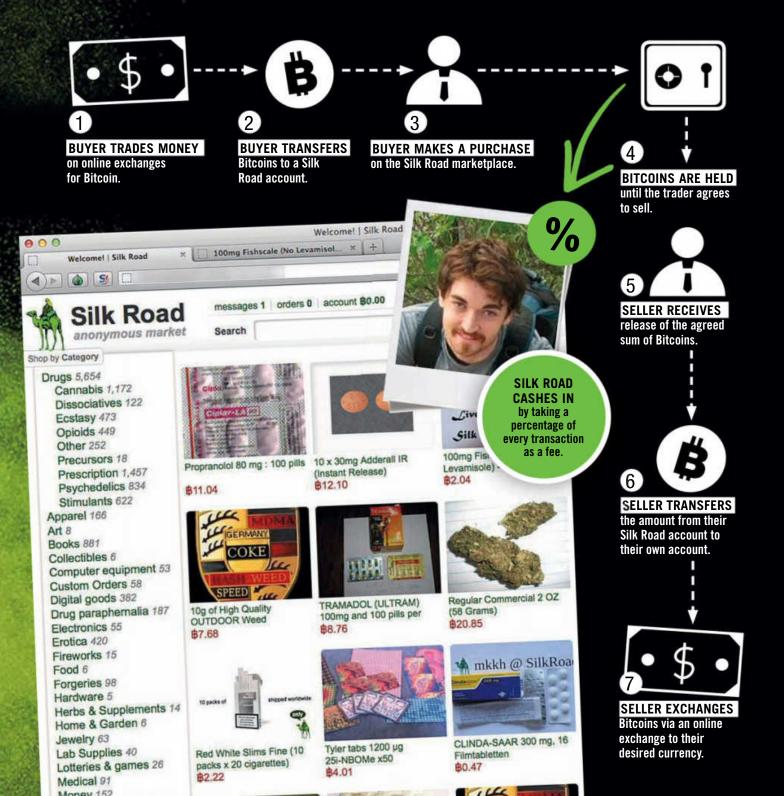


### How do you buy from the Dark Web?

Silk Road was shut down following Ross Ulbricht's arrest. But there are already copycat portals that rely on the same principle: in order to access them, you need to use a browser like Tor, which is a kind of digital invisibility cloak that allows for anonymous surfing on the

internet. It's the only way to access pages ending in .onion. Since these pages can't be found using regular search engines like Google, this part of the internet is known as the Dark Web. The illegal shops operate in a similar way to Amazon or eBay: they categorise products and buyers can

rate providers by the quality of their products or delivery speed. Goods are paid for by the virtual currency Bitcoin, a worldwide, decentralised digital money. Bitcoin doesn't have a central bank, meaning that all the connected computers collectively act as one. The goods are then posted.



where you can buy everything that Amazon doesn't sell. Contraband, essentially. Counterfeit passports, fake IDs, unregistered weapons, any type of drug imaginable – only child pornography, stolen goods and weapons of mass destruction are officially taboo.

Ross Ulbricht is the godfather of this shadowy world hidden away in the depths of the 'Dark Web', a parallel universe to the internet, and one that can never be catalogued by the usual search engines.

As the 29-year-old leaves his flat in San Francisco's Sunset District at noon on 1st October 2013, he's being followed. Half a dozen FBI agents have been monitoring him for days. They watch as the lanky young man crosses the road, and wait as he enters the Glen Park library. He heads to the sciencefiction section, gets out his laptop and logs on to the library's Wi-Fi. The place serves as Dread Pirate Roberts' gateway to the dark world of organised crime - and his accomplice Cirrus needs his help. He's waiting to talk to him online.

Cirrus is a forum moderator on Silk Road, and earns about \$1,000 per week. But what Ulbricht doesn't know is that, for the past two months, it's no longer his partner hiding behind the pseudonym, but federal agent Jared Der-Yeghiayan in Chicago - the real Cirrus's cover has been blown. And now undercover investigators, masquerading as science-fiction fans, are sitting just metres away from him as he logs on to Silk Road right under their noses. "Okay, what's up?" he types. It's the moment the authorities have been waiting for.

Everything happens in a blur. "I'm so sick of you," screams a woman, before lunging at Ulbricht and grabbing his laptop. Shocked, he gets to his feet and tries to get it



### Why did this man need to die?

Curtis Clark Green had a seemingly perfect family life in Utah as a professional poker player – and a secret part-time job for Silk Road. But his boss Dread Pirate Roberts (Ross Ulbricht) suspected that he was cooperating with the authorities – and so hired a killer. But the "killer" turned out to be an FBI agent, who only pretended to carry out the crime to get information about Dread Pirate Roberts' true identity.

back, but is quickly surrounded by other agents, who strip off their civilian tops to reveal FBI T-shirts. The most important piece of evidence is in the bag: a Samsung 700Z laptop, from which Dread Pirate Roberts controls his billion dollar empire. He uses it to recruit dealers, hire killers – and occasionally watch TV with his housemates. It's exactly 3.14pm

People from the highest echelons of government

are after me.

when the Silk Road empire collapses like a house of cards.

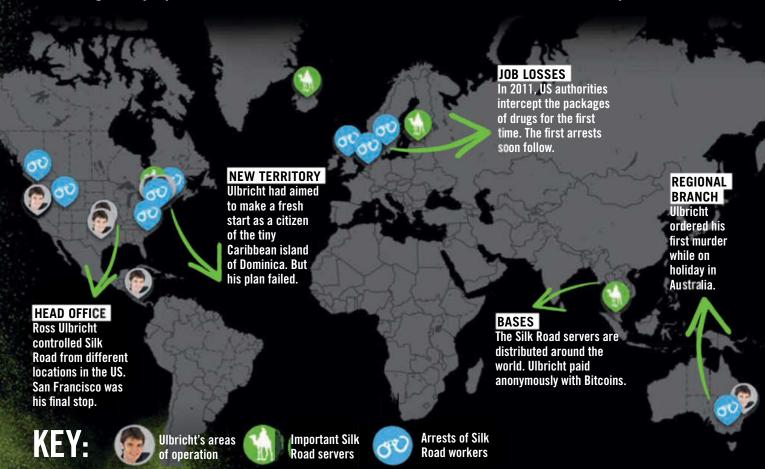
### HOW DO YOU EARN \$40 MILLION A YEAR – FROM YOUR SOFA?

"We needed to catch him redhanded so that he couldn't destroy any evidence," explains FBI agent Tom Kiernan. Ross Ulbricht had been expecting this day for a long time, as his empire had grown too large. "I'm Silk Road, the marketplace, the person, the company. Everything. People from the highest echelons of government are after me," wrote Dread Pirate Roberts months before his arrest

By this point, Silk Road had made over a billion dollars, 90% of it through drugs. The goods were posted to consumers. It was a safe method: even if the authorities intercepted the occasional package, they couldn't systematically search

### The system behind Silk Road

All you needed to become part of Silk Road was a computer with a decent internet connection – meaning virtually anyone could act as a trader, buyer or administrator. The risks were low because no one had to reveal their true identity. But this was also Ross Ulbricht's downfall: no one knew who was really at the other end of the line. It's still not entirely clear how authorities could crack the anonymous network.



the entire mail system. Ulbricht is living proof that the system works: as CEO he earned an estimated \$80 million. At its peak, the online portal had nearly a million user accounts and was the top-selling dealer worldwide, supplying a fifth of consumers in the US.

But Ulbricht could feel his pursuers breathing down his neck. "They know too much, damn it," he wrote in his diary. His home, the US, had become the most dangerous place on Earth for him to be. He needed out. So, before his arrest, he travelled to Dominica. For \$75,000 anyone can become a citizen of the

Caribbean island. The forms were already filled in. But the trap was sprung before he could finally quit the US. The amazing thing was that no one in Ulbricht's real life had the slightest inkling that he was the operator of an online drug cartel. But how was Dread Pirate Roberts transformed from a boy whose own father said was "never any trouble" into a ruthless godfather?

### HOW DO YOU BECOME THE BIGGEST DRUG DEALER ON EARTH?

Three years before his arrest, Ulbricht was broke. The physics graduate left a promising career as a scientist to deal in used books - without success. Honest, smart. helpful and full of ideas - that's how his family and friends, mostly surfers, musicians, yoga students and former scouts, describe him. He saw himself as a down-to-earth type, wandering around barefoot and living like a hippy. "I want a world free from state interference" was what he wrote on his LinkedIn profile. His mission was to establish a separate state on the Dark Web: "a site where anyone can buy anything without leaving a trace. A kind of anonymous amazon.com.

PHOTOS: Shutterstock; Laif; PR (5)

A trademark that people could trust." Silk Road emerged online in January 2011 under this motto, and Ross Ulbricht later became Dread Pirate Roberts.

From the very beginning, the business focused on drugs. To promote his platform, the teetotaller even became a producer. He rented a remote cabin in Texas, turned it into a laboratory, and kickstarted his business with hallucinogenic mushrooms. "I almost worked myself to death. But when the first

## These people know too much, damn it!

order came in, I was over the moon," said Ulbricht. Initially, he had concerns about supplying heroin addicts or sellers offering highly toxic goods like cyanide. But greed won out in the end.

Silk Road was growing rapidly, along with Ulbricht's power. His rules were uncompromising: "I'm the captain of this ship. If you don't like my rules, get off." In the first year he earned \$25,000 a month – money that helped recruit workers and build a fake front as a computer scientist and currency trader.

### HOW MUCH DOES MURDER COST ON THE INTERNET?

The job didn't just involve updating the website, responding to customer requests and unmasking fraudulent users. Dread Pirate Roberts also had to defend his empire against rival platforms like Sheep Marketplace, Atlantis and

### How many identities can a person have?

Nine names, nine IDs, one person: Ross Ulbricht bought these fake driving licences, which included a British one, in bulk.

The Silk Road boss used a different identity wherever he went. For example, his housemates knew him as Joshua Terrey.

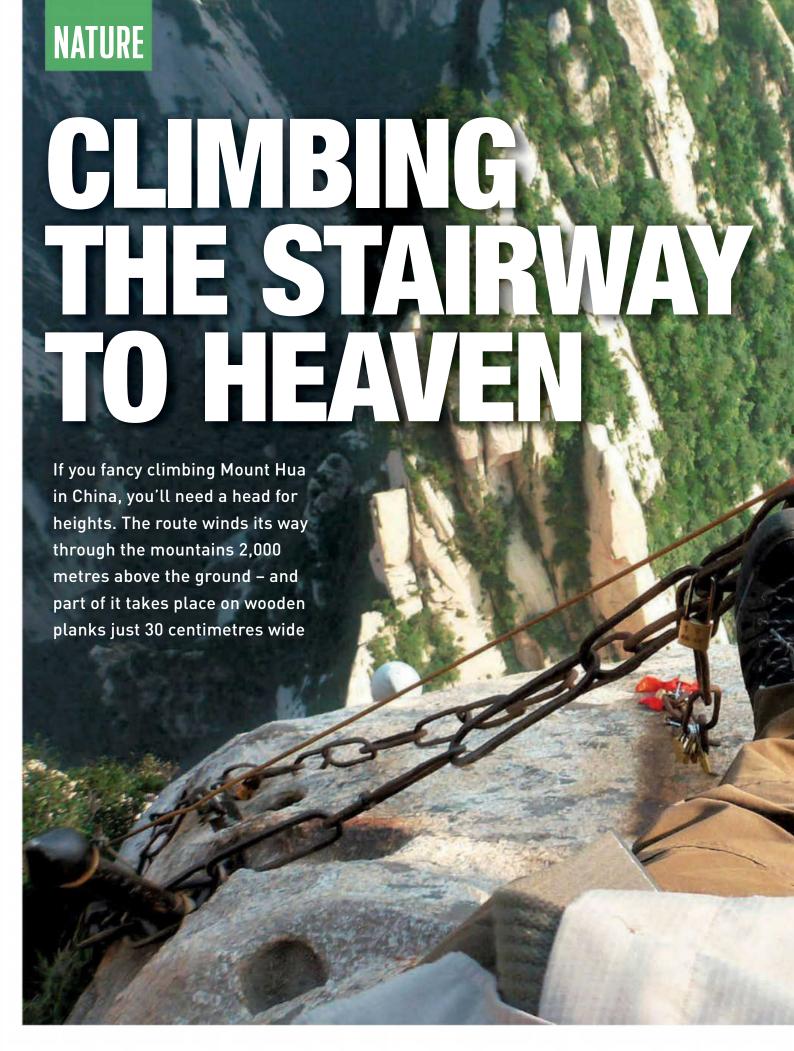


Black Market Reloaded. In a kind of virtual war, he hacked these sites to draw customers to his own. Ulbricht didn't want to let go of what he had built. But a special FBI unit soon infiltrated the system. Their first job? Unmasking Silk Road's mysterious CEO.

In January 2013, Ulbricht learned that his partner Curtis Clark Green had cheated him out of \$350,000 and possibly cooperated with the authorities. Chat logs show that Ulbricht wanted to "torture" Green to "get his money back again". Then he decided to murder him – just to make sure. "He knows too much, he could sing," he wrote. Ulbricht agreed a fee of \$80,000 with a hitman he

met online for Green's execution
– including "a video or photos
as proof of death." In total,
he ordered the murders of six Silk
Road users who crossed him. But
unbeknown to him, Ulbricht was
chatting with the FBI all along. The
murder wouldn't be carried out, and
any photos he saw would be faked.

In February this year, Ulbricht was found guilty of seven drug and conspiracy charges. Realising that his world had come crashing down, he wrote to the sentencing judge, Katherine Forrest, pleading, "I know you must take away my middle years. But please leave me my old age." It fell on deaf ears. On May 29th, Ulbricht was sentenced to life imprisonment – without parole.







ark
Laurence
shuts his
eyes for
a brief
moment
and takes
a deep

breath. It's now or never. Reaching up, he unclips his safety harness so he can capture an image of this moment 2,000 metres up. Just three centimetres separate him from a fatal plunge into the abyss. His pulse is racing; he can feel the adrenaline pumping through his body. After a short while, he turns around again and continues on his way, his gaze trained firmly on the flimsy planks beneath him.

Laurence is just one of thousands of thrill-seekers who attempt to

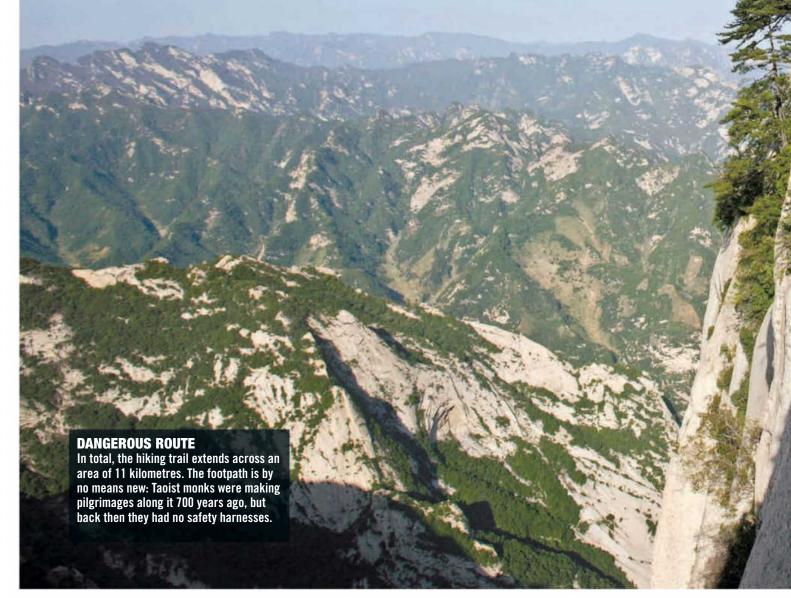
climb Mount Hua every year. For centuries the highest of China's Five Great Mountains has been the stuff of legend. Over the years, the steep cliff faces have cost many careless tourists and mountain guides their lives – and rumours abound that the deaths continue. Some say 100 people a year meet their maker here. Winter is particularly hazardous as the narrow boards to the summit are covered in a layer of slippery ice.

To scale the mountain, there are two options: you can put your feet up and take the cable car; or throw caution to the wind and climb the legendary 'Stairway to Heaven', a terrifying series of near-vertical steps which snake ever upwards through the clouds. Along this route, an optional turn will take you

to the vertigo-sufferer's ultimate nightmare: the *Changkong Zhandao* ('Floating-in-the-air Road'), which spirals along the southern peak for 50 metres.

### THE STAIRS ARE SO STEEP THEY LOOK MORE LIKE LADDERS

The start of the route appears harmless enough. But after just a few metres, danger is announced. Characters carved into the rock warn hikers in no uncertain terms: "Turn around!" Anyone not put off by the 4,000 steps that make up the Stairway to Heaven can follow its narrow paths through canyons and along steep rock faces to reach the northern peak. In the process, you'll have managed to complete the quickest route to the lowest of the five peaks.





At a height of 1,600 metres, a valley basin opens up, bordered by the southern, eastern and western peaks of Mount Hua. Mark Laurence chooses to ignore his burning calves and picks the route to the southern peak, the most difficult part of the hike. Thousands more steps lie between him and the top. Before long, heavy rain sweeps in, transforming the trail into a treacherous slide. The steps are now getting steeper, they're more like a ladder that's been carved into the rock face. At this dizzying height, parts of the route are simply holes in the rock acting as footholds. A rusty iron chain is the only thing to hold on to. Over the centuries, many of the footholds have been eroded by the weather and have become worn out from use. Maximum concentration is required in this critical area.

When Laurence eventually battles his way to the highest point, 2,154 metres up, he faces a true test of his courage. First, he clips his carabiner onto a wire safety rope and then negotiates a ten-metredeep crevice by shimmying down some iron bars. He's here at last. In front of him stands his goal: the Changkong Zhandao, zigzagging its way along a sheer rock face. His only support is a climbing harness. As Laurence balances on the rickety wooden boards, the abyss yawns below him. The wind tugs at his clothes.

Up here it can easily reach 70km/h - and that's on a regular day.

### WHEN SOMEONE COMES FROM THE OTHER DIRECTION. YOU'RE IN TROUBLE

Every two metres, Laurence has to clamber onto new boards and look for the next safety line to clip his harness to. The wood creaks ominously beneath his feet. What if it starts to rain? One slip here and he'd fall several metres until the tension on his climbing rope broke his fall. The carabiner could break - or the rope could snap. At the

### **Characters carved in the** rocks warn climbers: "Turn around!"

### //// The five peaks of Mount Hua ////

Mount Hua is one of five sacred mountains in the Shaanxi province. "Hua" means flower and is so named for the way the five peaks look like the petals of a lotus flower from above. The highest point of Mount Hua is the southern peak (seen partially covered in the background here). It is notorious for its steep rocky cliffs that at one time were said to have claimed the lives of 100 hikers a year. Many of the bodies have never been found.

### How high are the peaks?

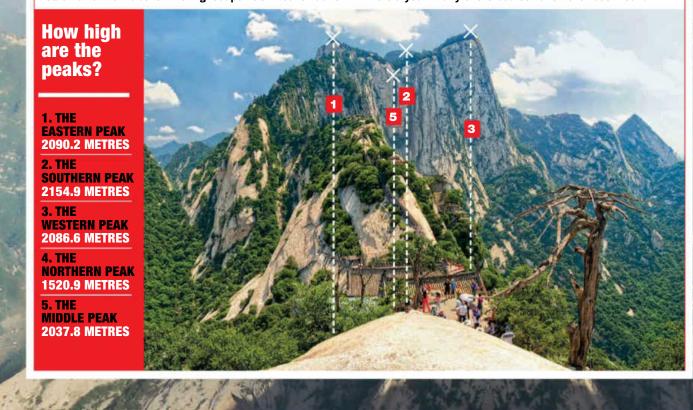
1. THE **EASTERN PEAK 2090.2 METRES** 

**SOUTHERN PEAK 2154.9 METRES** 

**WESTERN PEAK** 2086.6 METRES

4. THE **NORTHERN PEAK 1520.9 METRES** 

**MIDDLE PEAK 2037.8 METRES** 



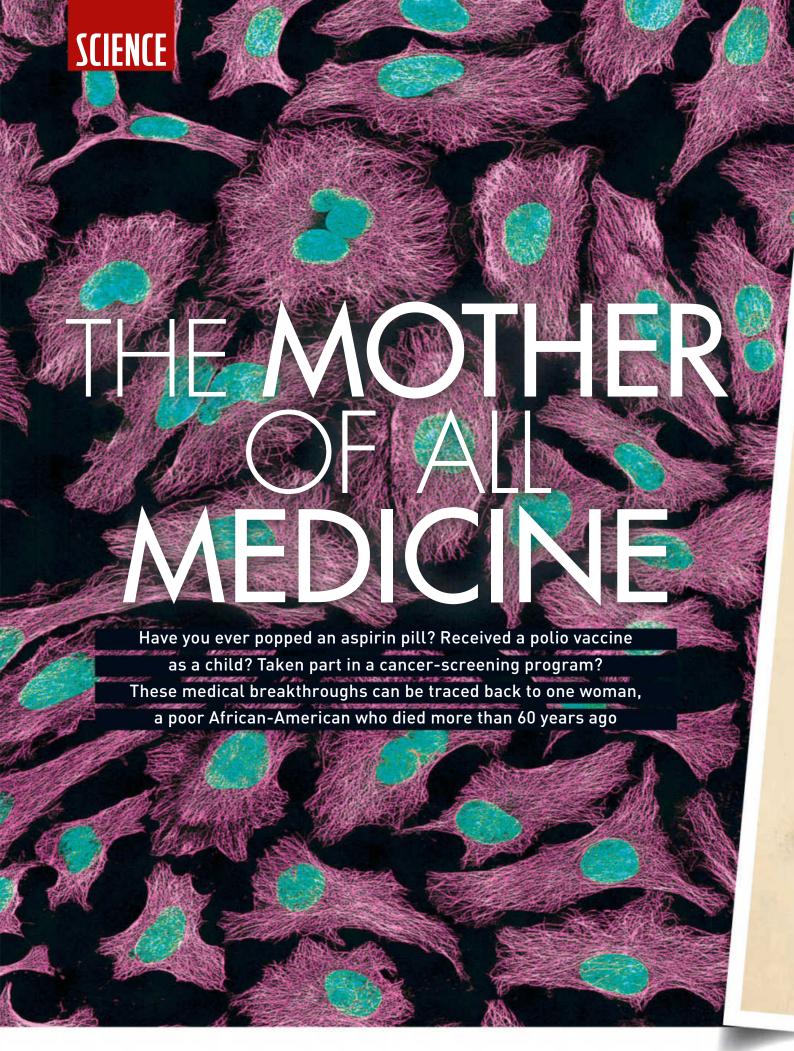
end of the boardwalk lies a small plateau. Laurence pauses before taking the return route back – following the exact same path.

This in itself presents a problem: in recent years, Mount Hua has become a popular tourist attraction. At this height, however, two-way traffic could have fatal consequences. Edging along the narrow planks in twos? Too risky. Even if every nerve in your body is urging you to carry on forwards and get the journey over with, there's no alternative but to battle your way back to the last wide point in order to let others pass.

Three-quarters of an hour later, Laurence feels solid ground beneath his feet again. Bathed in sweat, he briefly considers taking the cable car the rest of the way. But in the end, his own ambition triumphs over the pain again.

# **DON'T LOOK DOWN!**

The infamous boardwalk is made from three wooden planks, each just ten centimetres wide. These lie on top of metal brackets, which are attached to the vertically sloping cliff face.





not have understood. Informed consent was not on the radar of doctors in the 1950s – taking samples without asking was common practice, something that every hospital did. So it is without Henrietta's permission that small cuts of cells from her inflamed cervix are placed in glass tubes and ferried downstairs to Gey's office.

One of the very first things a new biologist learns is how difficult it is to sustain human cells in a laboratory for an extended period of time. That's because our cells are programed to commit suicide – a process scientists call apoptosis – after a set number of cell divisions. And once removed from their natural environment, most cells perish immediately.

"Henrietta's cells weren't merely surviving, they were growing with mythological intensity."

REBECCA SKLOOT

# WHY DID HENRIETTA'S CELLS SURVIVE?

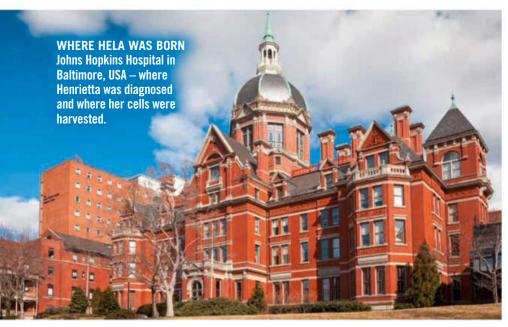
Gey expected Lacks' cells to act in the same way as previous tissue specimens: to do nothing, or perhaps to live for a day and then die. Sometimes cells showed promise, only to shrivel within a few hours. But when the test tubes containing Henrietta's tumour arrive in the lab, it quickly becomes clear that these samples are like nothing Gey has seen before.

Surrounded by the whirr of freezers containing cell samples from hundreds of patients, Gey stands over the petri dish, staring in amazement. The healthy sample quickly dies, but Lacks' malignant cells cling to the edges of the dish they have been placed in, consuming the medium around them. Overnight they double in size. "Henrietta's cells weren't merely surviving," says Rebecca Skloot, author of The Immortal Life of Henrietta Lacks. "They were growing with mythological intensity." Within days of being placed in culture, the sheet of cells grow thicker than any Gey has ever seen in his decades-long medical career. Here, finally, is the immortal human cell line that Gey has been seeking for decades. He names it HeLa - after its unknowing donor.



Less than ten months after being diagnosed with cancer, Henrietta's body lies in the hospital morgue – dead at the age of 31. A postmortem reveals her body is riddled with malignant tumours; the cancer has colonised her body, ravaging almost every vital organ.

But a small part of Lacks lives on, immortal. Once it became apparent that Henrietta's cells would not die under laboratory conditions, as all cells had done previously, scientific research exploded: because HeLa cells



# The History of HeLa

# 1920

Henrietta Lacks is born in Roanoke, Virginia.

# 1951

Lacks is diagnosed with cervical cancer. Tissues from her tumour are harvested without her consent and her cells used to create the world's first 'immortal' cell line. She dies that year, aged 31.

# 1952

A distribution centre is founded at the Tuskugee Institute in Alabama so that Henrietta's cells can be mass-produced and mailed to scientific institutions around

# 1952

The virologist Jonas Salk develops the first successful vaccine for polio using HeLa cells infected with inactive viruses.

# 1953

Researchers discover that staining HeLa cells with haematoxylin makes cell chromosomes visible, enabling the sequencing of the human genome and the identification of genetic conditions such as Down's syndrome for the first time.

# 1955

HeLa cells become the first human cells to be successfully cloned. Henrietta Lacks was born in Roanoke, Virginia on 1st August 1920. Mother to five children and married to her first cousin [pictured], she worked as a tobacco farmer in rural Maryland. Diagnosed with cervical cancer in 1951, she died just nine months later at the age of 31. Tumour cells taken from her body without her consent were used by physician George Gey to

create the HeLa cell line, a collection of tissues that reproduce infinitely in the lab and have become one of medicine's important tools. For many years, the source of the ubiquitous HeLa cells was unknown to scientists. It is only in the past decade that the identity of the woman who donated the cells and gave them their name has become more widely known.

reproduce endlessly and with such speed, all sorts of formerly unrealisable experiments became possible. Before HeLa, researchers spent more time trying to produce cells than they did using them to cure disease. The new line freed up time for vital research and allowed medicine to advance much more quickly than it would have.

Wherever Gey went, he travelled with a vial of HeLa cells in his pocket, keen to share his remarkable discovery with other scientists. Soon researchers realised HeLa even survived being transported in the mail, and a HeLa distribution centre was founded to produce the tissues en masse.

Biologists around the globe were suddenly able to watch cells dividing under the microscope and could see how bacteria and viruses invaded healthy cells, wreaking havoc on the tissue's vital processes. The cells also enabled doctors to subject human cells to

environments that would have been impossible were they using live humans as test subjects: scientists blasted HeLa with cancer-causing chemicals, bombarded the tissues with radioactive substances and even sent Henrietta's cancer into space on one of the first unmanned Soviet satellites to leave Earth's atmosphere. When astronauts first landed on the moon in 1969, HeLa accompanied them.

Astonishingly, as HeLa cells were posted to labs around the globe and millions of copies began to be produced, Henrietta herself remained almost entirely unknown. Every molecular biology student will have conducted an experiment using HeLa, so ubiquitous is the cell line grown from Henrietta's tumour, but – even today – few are informed of the provenance of these tissue cultures. In fact, for many years Henrietta was mistakenly

referenced as Helen Lane or Helen

referenced as Helen Lane or Helen Larson in textbooks – a measure perhaps intended to protect Henrietta's anonymity.

This had one unintended and shocking consequence: Henrietta's surviving family, including her five children, had no inkling that their mother's cells continued to thrive inside petri dishes around the

# 1960

Loaded onto a Soviet satellite, test tubes containing HeLa are sent into space before any humans. The cells later accompany the Apollo missions, proving cancer cells grow quicker in space.

# 1965

The first humananimal hybrid cells are created when scientists fuse HeLa cells with mouse cells.

# 1972

The Lacks family learn that their mother's cells are still alive when a scientist contacts them asking for additional genetic samples for use in further studies.

# 1973

HeLa is used to study salmonella cells and their behaviour inside the human body.

# 1984

German virologist
Harald zur Hausen
uses HeLa cells to
prove that the human
papillomavirus (HPV)
causes cervical
cancer, as it did in
Henrietta's case.



# What makes Hela cells immortal?

Medics are still unsure why HeLa cells thrive with such ferocity when cells usually die as soon as they hit the glass of a petri dish. Most healthy cells are programed to die after a certain number of divisions, but an immortal cell line is a collection of living tissues which, due to mutation, have circumvented the cell death mechanism. When Henrietta died, a post-mortem revealed that she was infected with syphilis as well as the human papilloma virus (HPV), which has been linked to an increased risk of cervical cancer. Some scientists believe that HPV-18, which HeLa cells contain, is behind the cells' mythical longevity. This particularly aggressive variant of HPV produces vicious proteins that allow cervical cells to multiply uncontrollably. HeLa's fabled immortality is precisely what caused Henrietta's own death - the cancer propagated so wildly that it took over Lacks' body with ferocious speed, killing her in less than a year.

world. Not only that – after her death, they remained completely unaware of the groundbreaking nature of her cells, unique in their immortality, and to the fact that their mother's tissues were becoming world famous...

# HENRIETTA'S CELLS LIVE ON IN THE LAB

It was not until the 1970s that Henrietta's widower, David Lacks, and surviving children learnt the truth about the far-reaching influence of their Hennie's cells. Twenty-five years after Henrietta's death, a scientist realised that many cell cultures in use in molecular studies around the world, thought to be tissues taken from breast and prostate cancers, were actually HeLa cells.

What followed shook the world of scientific research and revealed another astonishing characteristic of the cells removed from Henrietta Lacks' body: they are so virulent that they are able to float through the air on dust particles or the coat sleeves of scientists and contaminate other cell cultures. It was only then that researchers felt compelled to trace Henrietta's descendants, hoping to gain DNA samples so that they could check which cells had come from the HeLa line and which hadn't. And this was when the Lacks family learnt the startling truth: a small

part of Henrietta had survived her death in 1951 and was being kept alive in a test tube.

Perhaps no one would be more amazed to realise this than Lacks herself. As an adult Lacks stood at just over five feet tall, weighing 63 kilos before the tumour emaciated her body and claimed her life. But if her cells were laid out end-to-end today, they would stretch around the equator three times. And if it were possible to weigh all of the cells ever produced from the HeLa line, they would tip the scales at a staggering 20 tons. This number is particularly mind-boggling when you remember that each individual cell is virtually weightless.

The HeLa cells have also sparked a lively and enduring debate about medical ethics. The moral concerns surrounding the Lacks line are diverse and thorny. Lacks' cells have made some companies and individuals - in particular, pharmaceutical giants - rich to the tune of millions of dollars. Since HeLa cells started being produced in industrial amounts, tissue banks and biotechnology firms have been supplying vials of Henrietta's cells to anyone with a few hundred dollars spare. Today anyone, scientist or otherwise, can order a test tube of HeLa for roughly \$250. Many, including Henrietta's family, are indignant about this - Lacks' children still live in relative poverty

# The History of HeLa

### 1986

Researchers in the USA unlock the virus infection mechanism used by the human immunodeficiency virus (HIV) with the help of Henrietta's cells.

# 1989

A Yale University scientist discovers the enzyme in Henrietta's malignant cells that stopped them from dying by disabling the cell death mechanism. He names it telomerase.

# 2005

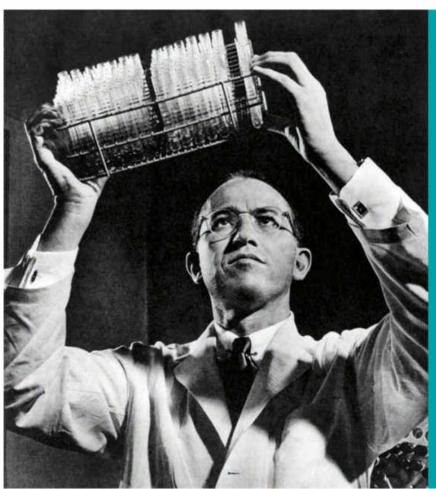
HeLa cells are used in nanotechnology research. Nanochips are placed inside living cells. It is hoped this will be used for the early detection of diseases in future.

# 2013

The US
government
restricts access to
the whole genome
data of HeLa cells
for biomedical
researchers at the
request of the
Lacks family.

# 2015

Though other immortal cell lines have built on the success of HeLa, Lacks' cells remain the popular research choice thanks to their resilience and rapid growth. The going rate for a vial of HeLa cells is \$250.



# How Hela helped to **CURE POLIO**

In 1951, the same year Henrietta Lacks lay dying, the US was firmly in the grip of the worst polio epidemic in history. By 1952 over 60,000 victims had succumbed and many more were paralysed for life. Jonas Salk, a virologist [left], was busy working on a cure. Using inactive viruses, he had created an injectable vaccine, but to test its effectiveness, he needed cells - masses of them. HeLa cells were the perfect carrier as they were highly susceptible to the poliomyelitis virus. What's more, they grew with ferocious speed, allowing Salk to produce the huge quantities needed to perfect his creation. In 1953, just two years after Lacks' death, the first humans were vaccinated in a trial. In no small part thanks to HeLa, polio was eradicated in the US in 1979 and in Europe in 2002. The **World Health Organisation hopes to** eliminate the disease entirely by 2018.

and many are without health insurance, despite the fortunes built on their mother's cells.

Ethical concerns aside, the impact of Henrietta's cells can scarcely be overestimated. HeLa has kickstarted the careers of thousands of scientists in the six decades since Henrietta's death. The same cells that robbed a young woman of her life have been cited in more than 60,000 scientific journal articles, a number that continues to rise - with ten more published every day. The HeLa line has unlocked some of the most enduring secrets of medicine, providing the answers to medical questions as diverse as the link between HPV and cervical cancer to the mating patterns of mosquitoes. Without HeLa, we would not be able to fertilise eggs in vitro, test chemotherapy regimens for cancer or know how

"She's the most important person in the world."

LAWRENCE LACKS, HENRIETTA'S SON

humans might react to cosmic radiation. Most famously, HeLa cells facilitated the development of a polio vaccine, helping to eradicate the disease in the US. The cells have been used to test the effects of cosmetics, drugs, radiation and household chemicals. Although other immortal cell lines have been cultivated since 1951, HeLa remains the most popular for its familiarity and durability, and for being so easy to store and grow.

Though Gey and Lacks never met, the two were bound together by something that would go on to alter the course of medical history and save thousands of lives. Were it not for the incredibly resilient nature of the cells that killed her, Henrietta Lacks – buried in an unmarked grave in rural Virginia – would by now be forgotten. But thanks to a twist of fate in the corridors of a Baltimore hospital, one woman's inadvertent gift changed medicine forever. Even in death, says her son Lawrence Lacks, Henrietta is arguably "the most important person in the world."



BOOK TIP
The Immortal Life
of Henrietta
Lacks by
Rebecca Skloot
(RRP \$26.99;
booktopia.
com.au)

# The honey badger SOUNDS SWEET... **BRAINY BADGERS!** Use the free viewa app and scan this page to discover why honey badgers "I attack WHERE ONLY I CAN!" This is what absolute determination looks like. The honey badger, also known as a ratel, is programed to attack as soon as it can, even when its enemy is a thousand times its size. Why? Because it has carefully studied the weak points of every animal in the savanna while having very few weaknesses itself.



# THE WEAPONS OF THE The honey badger is a real fighting machine. short as its menu is long. Zoologists have counted Using its specialised weapons, it can make almost 65 prey species – including scorpions, turtles, small any animal head for the hills. The creature has very few foxes, jackals, antelopes, a diverse range of snakes, genuine adversaries. In fact, its list of enemies is as chimpanzees, young leopards and even small crocodiles! Stink bomb Next to its more sophisticated weapons, this one looks rather primitive - though it's effective. The honey badger sprays attackers with a putrid liquid from its anal glands. Poison centre Honey badgers have a super-liver that can break down poisons in the body. This makes the animal immune to every scorpion and poisonous snake in the whole of Africa. Defence wall The thickness and density of its coat mean it's virtually impossible for teeth or claws to pierce its Difficult rubbery protective layer. The only to pin down The honey badger's skin is remarkably loose – so loose in fact that it can twist freely within it and turn on attackers, even when held. Don't ask us how...

he lion is still considered to be the undisputed king of all the beasts. And it's safe to say that pretty much all of the animals that roam the African savanna have a healthy respect for the mighty lion. All bar one, that is: the bold-as-brass honey badger. Also known as a ratel, at 80cm long and

weighing 15kg, it's not the most physically imposing creature. But unlike their European cousins, the honey badger is a bit of a nightmare. For the lion, especially. As the old saying goes, the lion likes to keep its friends close and its enemies closer – but the honey badger is an expert at giving it the slip. In fact, nature footage

proves that it's lions who are often the ones to beat a retreat after a confrontation with the tooth-baring master of mayhem.

Let's take a closer look at a day in the life of *Mellivora capensis*. As the sun sets on the African savanna, the honey badger can be found on its usual 40-kilometre patrol: the same old path it trundles



# **FAQ: HONEY BADGERS**

# WHERE ARE THEY FOUND?

The honey badger is found throughout Africa
— in desert, rainforest or mountainous regions up
to 3,000 metres high. The ratel can also be found
wreaking havoc in some parts of Asia. The first
written description of the animal dates back to
1776. They were thought to be a relative of the
European species of badger.

# WHERE DO THEY LIVE?

The honey badger's range is about 105 square kilometres. The animals often have several dwellings within this area. These could be tree hollows, rocky caves or abandoned burrows. It always marks its territory with its pungent anal fluid.

# DO THEY HAVE FRIENDS?

• Honey badgers are introverts who'll happily spend most of their time alone. In fact, given their tyrannical nature, it's hardly surprising that their social circle is so small. That said, there is one animal that could (sort of) be called a friend: the honeyguide [pictured]. As their names suggest, the pair have bonded over a shared passion: honey. Ornithologists have cast doubt

on the widely accepted belief that the bird hunts down the bees' nest and then calls for the honey badger to break into the nest. But the honeyguide is certainly quick to move in once the honey badger has finished gorging itself, happily feeding on the remaining leftovers.



# ...WHAT ABOUT MATING?

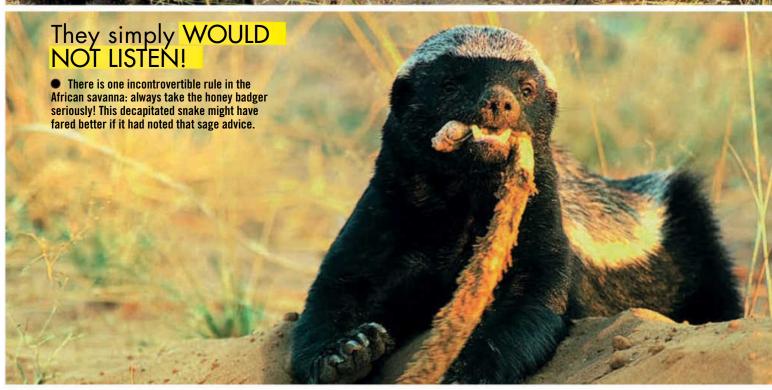
Hardly worth a mention: the males and females are loners who only meet up during the mating season. The gestation period is 150 days and one to two young are carried during a pregnancy.
 In captivity the ratel can live for up to 24 years – but the life expectancy of wild specimens has not been researched.

along daily in its search for food. But all of a sudden it screeches to a halt, sending a cloud of dust into the air. Towering in front of it is an African puff adder – one of Africa's most feared and venomous snakes. A snake so dangerous that its bite can kill a fully-grown human within minutes. But nobody seems to have told the honey badger this –

and even if they had, it probably wouldn't care. Throwing caution to the wind, the ratel lunges at the startled snake and snaps its jaws shut, expertly decapitating the animal in the process. Just seconds later, though, the honey badger starts to lurch from side to side. What's wrong? Unfortunately, it failed to notice the adder drilling its

deadly fangs into its stomach before the snake met its maker. The honey badger keels over, and lies there, motionless. Was taking down the savanna's most gutsy resident really that easy? Of course not. The venom has only rendered the ratel unconscious. Because there's one thing you can't see from the outside: a remarkable





metabolic process is happening inside the honey badger's body. The snake's venom is being neutralised and, as if none of this had ever happened, the ratel is back on its feet within five hours. The honey badger's highperforming liver grants it immunity against every type of scorpion –

and the venom of Africa's snakes.

Nasty, belligerent and arrogant – that's probably how a lot of animals would describe the honey badger. But where does this bad rep come from? Well, it could be down to a particularly underhand hunting strategy. It's one that doesn't win it any friends, though it is very

effective. In fact, using this ploy it can even head off a one-ton water buffalo. Impossible, you're thinking, just look at the size difference. But it's true. The honey badger manages it by sneaking up on its chosen victims and biting them right where it hurts. That's right – directly on the genitals. Then it





needs only to hide and wait for the animal to bleed out. Other animals alleged to have been attacked in this way include wildebeest and zebra. One thing's for sure: it's not a tactic for the squeamish.

And because it doesn't just pick fights with water buffalo, but also lions, leopards and hyenas, one study has reached the following conclusion: the honey badger is the most fearless animal in the world – a title bestowed on it by the Guinness Book of World Records.

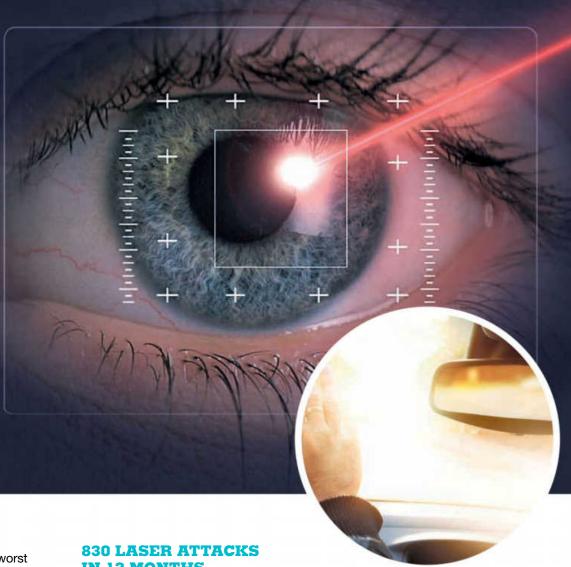
But the creature does have one major weakness: a fondness for honey. Researchers have found honey badgers stung to death next to bees' nests. But they couldn't explain how the bees brought the fearless ratels to their knees. "Too many stings, too much bee venom. Everything probably combined and their system couldn't cope," says biologist Marcus Neumann. A sticky end if ever there was one...

Knowledge LABTEST The TRUTH about INVISIBLE LASERS Imagine a weapon that no one can see or hear and one that leaves no trace. Well, such a weapon exists. It's a laser that can hit a person from hundreds of metres away, without them noticing. And it can be bought online for less than \$100



# How dangerous is an IR laser?

An infrared (IR) laser's danger lies in its invisibility. It means that you can be exposed to IR radiation for a long time without realising. This can lead to significant damage to the retina – or even complete blindness. IR lasers are therefore unpredictable weapons. "Aiming them at people can have disastrous consequences," says Martin Knowles from the UK's National Police Air Service.



t's every driver's worst nightmare: doing 100km/h on the highway when suddenly your vision becomes blurred.

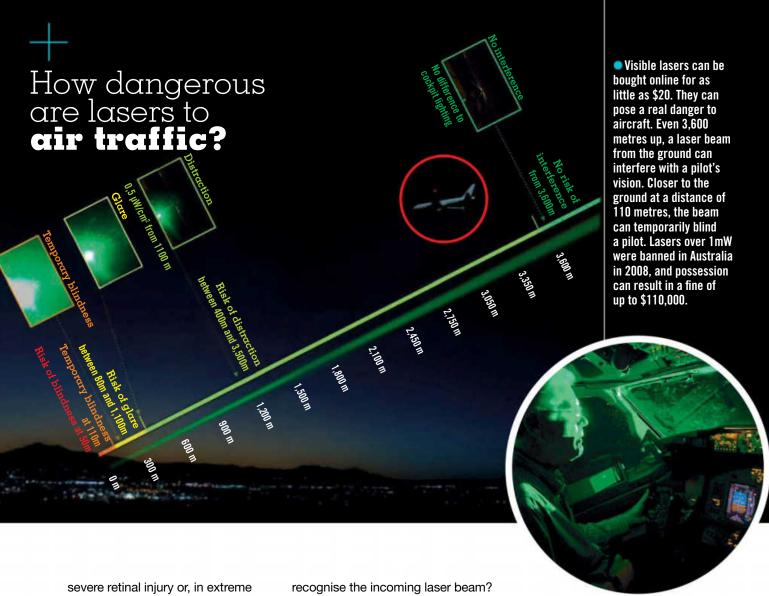
Everything goes dark: the road and other cars are barely visible. The driver slows, but not before the car has veered dangerously close to the central reservation. Badly shaken, he pulls over to the hard shoulder and phones for help. Although he can remember the incident in detail, he can't explain his temporary loss of sight. Breakdown services and the police are similarly at a loss. Blood tests show no trace of alcohol or drugs. Previously, there was only one theory: a blackout. Recently, though, accident investigators have been considering another explanation: a new type of laser, that, in the wrong hands, could have deadly consequences...

# **IN 12 MONTHS**

Laser attacks on motorists, pilots and train drivers are becoming more and more common. Airlines are particularly worried. In one year, an astonishing 830 laser incidents were reported to the Department of Infrastructure and Transport. The bright beam from hand-held laser pointers can blind pilots, especially during the critical take-off and landing phases. Pilot Andy Shanks says he's been hit "countless" times by laser pens during his career.

"It's disorientating, makes it impossible to focus on the instrument panel," he says. The fact that these attacks have not yet led to a plane crash is mainly due to pilots seeing the laser beam and reacting in time - something that would be impossible with an invisible infrared laser.

But how does this new high-tech weapon work? What makes it so unpredictable? And how easy is it to buy one? The wavelengths of light visible to the human eye range from 380 nanometres (nm) to 780nm. We can't see ultraviolet light (under 380nm) or infrared light (over 780nm). Conventional laser pointers of the sort widely used for presentations can be bought for as little as \$20 and use red laser diodes with a wavelength of 635nm to 750nm. You can change to a green, yellow or blue light by altering the frequency. The most powerful have a range of up to 5,000 metres, and if these lasers focus on the human eye for more than a second they can cause a



severe retinal injury or, in extreme cases, irreparable blindness.

Even more dangerous are those laser pointers that have additional infrared radiation – often not specified on the device – which results in a very intense beam.

Thankfully, eye damage is extremely rare because the body's movement counteracts the movement of the laser using the blink reflex to protect the eyes. The blink reflex normally closes the eyelid within 0.25 seconds of the stimulus occurring. But what happens if this reflex is bypassed because the eye can't

An invisible infrared laser emits its light at a wavelength of 1,300nm. Because this infrared light is invisible to the human eye it doesn't trigger the blink reflex. The result? The laser burns the retina. So a person doesn't notice if an invisible infrared laser hits them until it's too late – all of a sudden they just can't see. This blindness can last from a few minutes to a lifetime, depending on the duration of the burning and the strength of the laser. One milliwatt is enough to damage the eye in less than a second – if the

victim stays still. A 30mW to 40mW laser 5,000 metres away, meanwhile, can irreversibly damage the retina in just a tenth of a second. What's more, the source of the laser can't be detected because there's no visible beam. No trace, no witness.

Experts have long warned against the dangers of infrared radiation in lasers. Even though you need a permit to import any laser pointer over 1mW into Australia, they're available to buy on the internet. One such laser, the name of which we have decided not to publish, is advertised as being able to fit in your pocket, having a range of 3,000 metres and being invisible. Sounds like an accident waiting to happen.

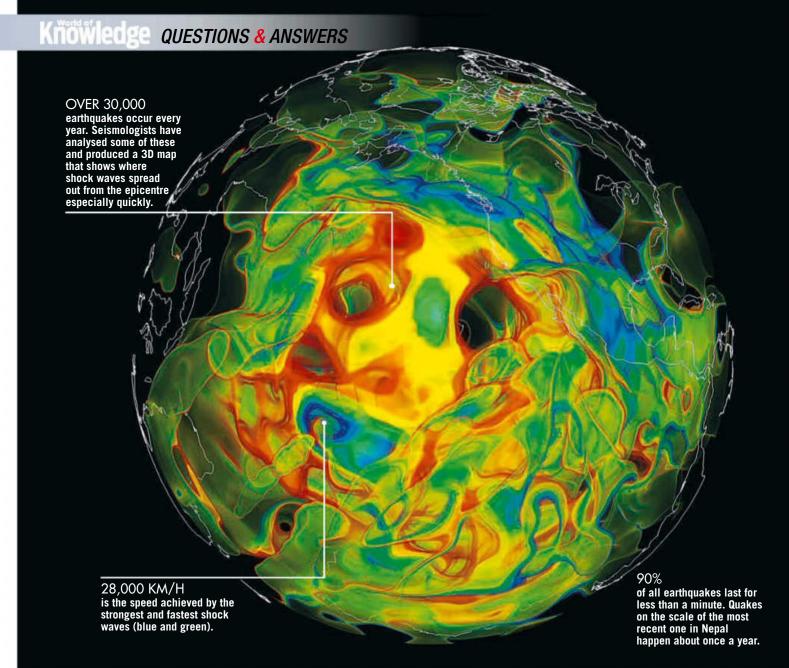
"Invisible lasers pose
INCALCULABLE RISKS"

Laser technician DR HOLGER KOCH

# Knowledge QUESTIONS & ANSWERS







# CAN YOU PREDICT AN EARTHQUAKE?

Most earthquakes occur where two tectonic plates meet. Below Nepal, for example, the Indian and Eurasian plates border one another. Enormous tension has built here over centuries. Although Nepal's recent quake caught the country's inhabitants by surprise, it had

long been predicted by geologists. Roger Bilham of the University of Colorado estimated that its hypocentre, the point where the pent-up energy would be discharged, would be just a few kilometres west of where it occurred. But the Himalayas are not the only tremor-prone region.

# 

# 1/SANTIAGO, CHILE



The risk of a megaquake in Chile's densely populated capital is extremely high. Enormous tension has built up on the nearby plate boundary.

# 2/TOKYO, JAPAN



Tokyo has the most earthquake-resistant buildings in the world – for good reason. The likelihood of a big quake in the next 30 years is estimated at 98%.

# 3/ISTANBUL, TURKEY



Istanbul's ten million residents are under threat as the metropolis lies on a tectonic plate boundary. The risk of an earthquake in Turkey's largest city is 60%.

# TOP 10

DEADLIEST WARS IN HISTORY\*

# 1. World War II

1939-1945

**Deaths: 65 million** 

# 2. Mongol Conquests

1206-1368

**Deaths: 35 million** 

# 3. An Lushan Rebellion

755-763

**Deaths: 30 million** 

# 4. Qing Dynasty defeat of the Ming Dynasty

1616-1662

Deaths: 25 million

# 5. Taiping Rebellion

1851-1864

Deaths: 20 million

# 6. World War I

1914-1918

**Deaths: 18 million** 

# 7. Conquests of Timur

1369-1405

**Deaths: 15 million** 

### 8. Chinese Civil War

1927-1949

Deaths: 10 million

# 9. Russian Civil War

1917-1921

**Deaths: 9 million** 

# 10. Second Congo War

1998-2003

**Deaths: 5 million** 

# CAN A SCARF MAKE ME INVISIBLE?

Will unflattering photos of celebrities stumbling out of nightclubs soon be a thing of the past? Designer Chris Holmes has created a 'camouflage' collection that helps to hide a person when they are photographed. The trick? A highly reflective layer ensures that

the light rays generated by a camera's flash are interrupted and reflected back. Clothing then appears like a white silhouette in the photo, while the face is underexposed. Worried paparazzi and gleeful A-listers can get more info at www.tinyurl.com/pf77rmn.





# Are there still glaciers in Africa?

It's fair to say that Africa isn't really known for snow and ice. But several tropical glaciers do exist on the continent. In the image below you can see a slice of glacier ice on Kilimanjaro in Tanzania – Africa's highest mountain. The question now is just how long the ice will remain.

Near the summit of Kilimanjaro, the ice sheet is only a quarter of the size it was 100 years ago. The glaciers of Mount Kenya and the Rwenzori Mountains are also melting, slowly but surely. Estimates suggest that Africa's remaining tropical glaciers will have all disappeared by 2030 at the latest.

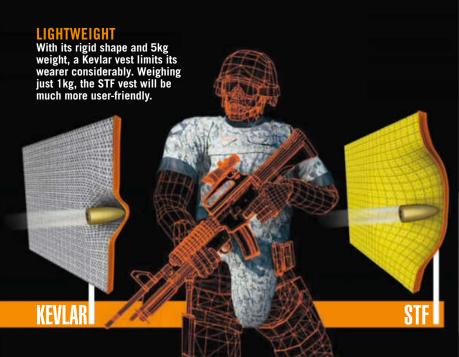


# WHAT COLOUR SIGNIFIES CALMNESS?

Green – at least as far as the panther chameleon is concerned. The reptile is known for its amazing ability to change colour; it can transform its skin in seconds. The change is mostly used as camouflage or to impress the opposite sex. For a long time, scientists were puzzled by exactly how chameleons managed to change colour. Then there was a breakthrough, as researchers discovered that nanocrystals are behind the psychedelic colour play. The reptile's skin contains special cells called iridophores, arranged in

consecutive layers that reflect the light that hits them using crystals. The way the nanocrystals are arranged and the distance between them determines the colour of a chameleon. When the reptile is in a relaxed state, the crystals sit close together and reflect short-wave blue light. Combined with the predominantly yellow pigments of its skin, this appears as a green colour. When the animal becomes agitated, its colour changes to orange. The crystals lie much further apart and reflect long-wave red light.





# CAN A LIQUID STOP A BULLET?

Kevlar is considered a miracle material that can stop almost any bullet. But the substance has its downsides: if a shot hits a vest made from Kevlar, a powerful shock wave is generated [see diagram, left]. This can cause serious damage to the internal organs. Now Polish researchers have developed a new material that can rectify the problem: Shear-Thickening Fluid (STF). This viscous-like syrup consists of nano-particles made from silicon dioxide, which help the shock wave to spread over a larger area and weaken its effects. STF also hardens when the bullet hits, and lessens its impact as a result.



# WHERE DO **BLOSSOMS** RAIN FROM THE SKY?

Every year in late spring at Japan's Ashikaga Flower Park, 65 kilometres north of Tokyo, the sky turns a beautiful lilac-blue colour. It's the moment when the Japanese wisteria plant begins to shed its millions of petals and fills the air with the heady scent of the flowers. This Asian

climber can grow to be 30 metres high and normally lives for around 50 years. The wisteria in the Ashikaga Flower Park, however, is a truly unique natural phenomenon, being 145 years old and measuring a staggering 2,000 square metres at its widest point.

# SHIT IN MARKET STATES OF THE SHARE STATES OF T

When this young Cooper's hawk claps eyes on a wasp for the first time, it is filled with wonder and instinctively snaps away. It could be a lethal move – for the bird

kay, so living in a bird sanctuary, far from the hustle and bustle of the great outdoors, does have a few things going for it: keepers bring tasty snacks in the form of mice, meals are served at the same time every day and there are no predators or enemies to keep an eye out for. It's an uncomplicated routine, one that this young Cooper's hawk has quickly become accustomed to.

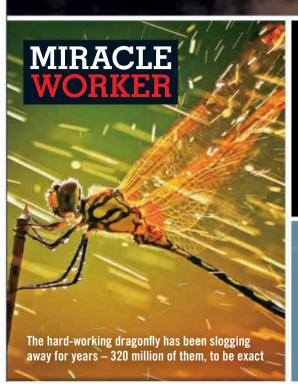
But hang on a second. Where's that loud buzzing coming from? As if from nowhere, a wasp suddenly appears right in front of the Cooper's hawk. Being just a few weeks old, this juvenile representative of the *Accipiter cooperii* species has never seen one of these black-and-yellow striped mini-drones before. It opens its eyes wide, focuses on the unfamiliar

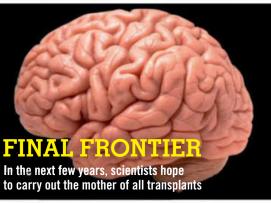
flying object and begins to screech hysterically. This mysterious troublemaker must be done away with, that much is clear. Fractions of a second later, the raptor instinctively opens its beak. What the young hunter doesn't know is that birds aren't immune to wasp stings either. A jab in the neck from the insect's poisonous barb could be fatal.

But it looks like this rookie has luck on its side: the Cooper's hawk misses the 30km/h invader by just a few millimetres and instead snaps its beak at thin air. The wasp escapes and the baffled attacker is left with nothing. We can only hope that the young bird of prey takes this as an opportunity to learn that, given their size and agility, wasps aren't a feature of the Cooper's hawk diet.











\*Changes to content are possible

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The dawn chorus was surprisingly loud loud enough to wake me from a deep sleep. The chirps, whistles and hoots of dozens of unseen Budgies, Cockatiels and Zebra Finches combined to make me wonder whether I had woken up inside a pet shop rather than beside an outback waterhole.

Before long, a hundred other birds had joined in. From the warmth of my sleeping bag I recognised the sweet melodies of a Brown Honeyeater, a piping duet by some Pied Butcherbirds and some chirruping woodswallows, but much of the rich birdsong outside my tent was unfamiliar to me. And I knew that plenty of other birds would be gathering silently at the waterhole in the predawn blush for an early-morning drink to get their day under way. Punctuating the birds' symphony was the harsh screech of a Barn Owl, probably just going to bed, to signify that the night shift was officially over.

Fast forward a couple of months. I was walking to work — a daily trudge along Elizabeth Street, amid the clatter of trams and the rumble of traffic in the early morning rush hour - when above the din I heard the calls of an angry Little Raven. When I looked up, I saw a raven flying past, hot on the tail of a Barn Owl - in broad daylight! Flying down the middle of the street, just above the trams' powerlines, the raven flapped frantically, contrasting with the buoyant flight of the crisp, white owl as it floated by. All this virtually in my 'back yard'!

Perhaps the owl had been slumbering among the rafters of the nearby Queen Victoria Market when it was discovered by the raven, scavenging for some early-morning scraps. It was a wonderful sighting but no one else in the busy street even noticed the owl fly past.

This chance sighting made me realise that it doesn't matter where your 'back yard' is whether it's a waterhole in the Red Centre or a bustling city street — if you're somewhere in Australia, you can be sure that you'll see birds wherever you look.

However, Barn Owls aren't your typical backyard bird — you're far more likely to see a Rainbow Lorikeet, Noisy Miner or Australian Magpie. I know this because last year I took part in BirdLife Australia's Aussie Backyard Bird Count. All I had to do was spend 20 minutes counting the birds I saw in and around my back yard. I didn't see any more Barn Owls, but there were plenty of other interesting native species added to my backyard bird list.

The good news is that the Aussie Backyard Bird Count is on again in 2015, between 19-25 October, and BirdLife Australia is keen to hear from anyone who is interested in the birds that venture into their back yards. It's easy and it's fun, but there's a more serious side too — the results will help BirdLife Australia understand the everyday birds which live in proximity to people.

> Text by John Peter Images by Andrew Silcocks







For more info head to aussiebirdcount.org.au or download the Bird Count app.

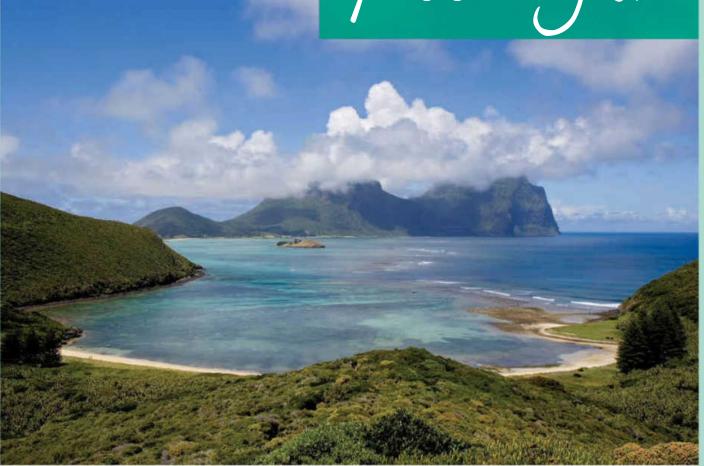








# free night







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